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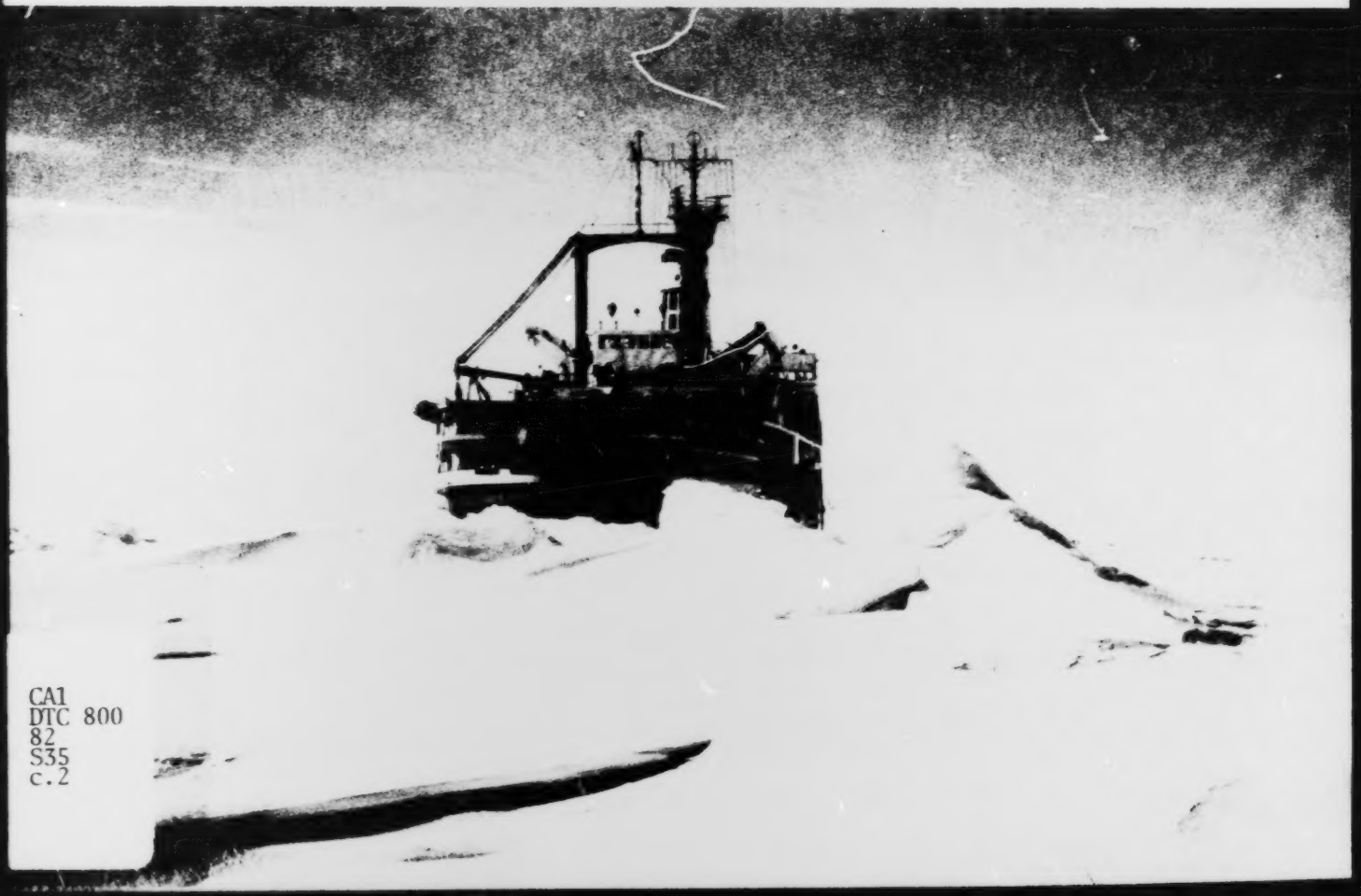
TP 3855E

Ships Navigating in Ice
A Selected Bibliography

Prepared by the
Transportation Development Centre



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Ships Navigating in Ice
A Selected Bibliography

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This Selected Bibliography has been compiled by the Transportation Development Centre, Transport Canada, Montreal, with the assistance of Daphne Sanderson and Gordon Smith under contract. Its purpose is to support marine transportation research and development projects pertaining to ships navigating in Canadian ice covered waters.

The volume contains research reports, papers published in technical journals, articles selected from open literature and unpublished material available from the period 1970 through to December 1980.

Acknowledgements

The authors would like to thank the following for their permission to reproduce abstracts:

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Calgary, Alberta T2N 1N4

BSRA
British Ship Research Association
Wallsend Research Station
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Cold Regions Research and
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U.S. Army Corps of Engineers
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Engineering Index Inc.
345 East, 47th Street
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MRIS
Maritime Research Information Service
Transportation Research Board
National Research Council
2101 Constitution Ave., N.W.
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NSFI
Ship Research Institute of Norway
Technical University of Norway
N-7034 Trondheim-NTH, Norway

NTIS
National Technical Information Service
5285 Port Royal Road
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SNAME
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Calgary, Alberta T2P 2L2

NORDCO Ltd.
P.O. Box 8833, Kenmount Rd.
St. John's, Newfoundland A1B 3T2

REPORT DOCUMENTATION FORM

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15. Supplementary Notes	16. TDC Project Officer
	A. Hope

17. Abstract

The volume contains research reports, papers published in technical journals, articles selected from open literature and unpublished material available from 1970 through 1980. Topics covered are:

Economic Aspects

Ice Accretion and Control

Ice Breaking, Ice Transit Operation and Methods

Ice Collision Damage, Shipwreck and Trapped Vessels

Ice Navigation - General

Model Testing, Simulation Studies, Etc.

Navigational Aids and Data Gathering (On-Board)

Propulsion Systems and Technology

Research Facilities, Policies and Programs

Ship Trials and Performance

Ship/Ice Interaction (Including Offshore Structures)

Vessels - Description and Design Information

Related Bibliographies

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	14. Code de l'organisme parrain
15. Remarques additionnelles	16. Agent de projet — CDT
	A. Hope

17. Résumé

Ce volume regroupe des rapports de recherche, des articles tirés de revues techniques et autres, et des documents non publiés, le tout couvrant une période de 10 ans, soit de 1970 à 1980. Les sujets traités sont les suivants:

Aspects économiques de la navigation des glaces

Accumulation des glaces et lutte contre ce phénomène

Bris des glaces, méthodes et rapports de navigation dans les glaces

Avaries, naufrages et cas d'emprisonnement dans les glaces

Navigation dans les glaces en général

Essais sur modèles réduits, simulation, etc.

Aides à navigation et systèmes embarqués de saisie des données

Appareils et technologies de propulsion

Installations, programmes et orientation de recherche

Essais et performances des navires

Interaction dynamique navires/glaces (structures flottantes comprises)

Description et fiches techniques des navires

Bibliographies connexes

18. Mots-clés	19. Diffusion
Navires, navigation, gel, glaces	Le CDT dispose d'un nombre limité d'exemplaires

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Introduction

Background

The Marine Transportation R&D Advisory Board (M.A.B.) is a joint industry/government body formed to advise Transport Canada of the problems experienced in marine transportation that may require an R&D effort to resolve. To do this effectively the MAB requested to be informed of all marine R&D to-date. To fill this need a number of publications were to be compiled, including a bibliography on the subject of ships navigating in ice. With these publications the board would have an up to date knowledge of the status of marine R&D in Canada and be able to identify gaps in technological knowledge which require investigation. Transportation Development Centre (TDC) in Montreal was tasked to compile the bibliography on ships navigating in ice.

Purpose

The bibliography is intended as a reference publication for the MAB but, a sufficient number will be printed for distribution to ship designers and ship operators. The purpose is to make the reader aware of the knowledge available, or not available, in this particular subject. It is also intended to encourage technology transfer which hopefully will avoid duplication of effort and cost already expended.

Note on Proprietary Material

Although the information contained in this bibliography gives a good indication of the work already done, some problems concerning proprietary information are recognised and are understandable considering the competitive nature of such activities as offshore petroleum exploration and transport. There is much proprietary material that was not made available for inclusion, therefore the bibliography cannot be complete until such times as the industry recognizes the overall benefits of a comprehensive bibliography. The proprietary information is not required for the bibliography. All that is needed is the title, author, and a small abstract which does not reveal any proprietary data.

A study group in the Department of Fisheries and Oceans recently released a report based on interviews and discussions with key marine personnel in government and industry. One of the conclusions in this report states "...The growth in economic importance of offshore resources and the corresponding haste for exploration and development has led naturally to a mushrooming of consultants, engineering firms, manufacturers and other secondary industries anxious to meet the needs of developers. Concurrently, there has been a requirement within government to expand environmental research and monitoring in areas of offshore industrial activity to maintain a regulatory and management role. Where government resources have been unable to respond to the pace of exploration, industry has been forced to undertake its own studies. Therefore, there exists a situation conducive to duplication and waste. Data is being gathered and research undertaken in a fragmented and piecemeal fashion. Not only is industry unaware of many of the research projects being undertaken by government and vice versa, there is also a lack of awareness of research projects amongst industries and within government...".

This statement, although applying specifically to the environmental field, is most certainly true of other areas as well. This bibliography is an attempt to alleviate some of these problems. If some entries appear to duplicate or overlap on others, that is entirely possible. Along the same lines, if there appear to be large gaps where no formal research is being conducted, two possibilities exist. Perhaps work is being carried out, but it is believed to be of a proprietary nature and therefore remains confidential and unreported, or else a gap really does exist. Hopefully, in the latter instance, this problem will become apparent to the reader of this bibliography and a more comprehensive approach will be taken in future.

Coverage

This is a SELECTED bibliography:

- not all publications have been included but, care has been taken to include all that is representative. For example, not everything that has been written on "Ice Accretion" has been included but, sufficient material has been selected to adequately cover that particular concern.

- ice conditions were excluded except ice atlases and other such publications required for planning a voyage. All other written material on ice conditions, such as the phsysics and mechanics of ice were excluded. There is such a mass of this kind of material on ice that its inclusion would have directed attention from the principal subject as well as making the bibliography cumbersome.

- the time frame selected was from 1970 to 1980 with the exception that material from Russian and Swedish sources would be from 1965 to 1980.

- emphasis was placed on finding written material on the theory and practice of ship navigation in ice, and operations in winter conditions in Canada. Material written or recorded as input for reporting organizations was not considered relevant as the operator can obtain this from the reporting organizations.

Other relevant material for inclusion is: Full and model scale performance trials in ice — Escorting and convoying in ice — Incidents of damage and loss from collisions with ice — Ship routing studies and transit models — Ship handling techniques and devices for transiting ice covered waters — Towing in ice — Propulsion technology and systems — Ship/Ice interaction — Related bibliographies.

Schedule

The project involved two phases. Phase I concentrated on published material from open literature sources and data bases and was carried out by TDC staff with a librarian under contract.

Phase II concentrated on finding unpublished studies, reports and papers. This required a technical knowledge and personal contacts in the marine industry, a marine consultant was engaged to carry out the research.

Project Administration

An advisory group of representatives from:

Canadian Marine Transport Administration (CMTA)
Atmospheric Environment Service (AES)
Arctic Petroleum Operators Assoc. (APOA)
Canadian Shipbuilding & Ship Repair Assoc. (CSSRA)
Department of Fisheries & Oceans (DFO)
Marine Advisory Board (MAB)
Transportation Development Centre (TDC)

was formed to assist the TDC project officer.

Availability of documents

Source List — Published Material

In most cases, a variety of means exist for obtaining documents, and the choice of method will be dependent to a great extent on the nature of the document, the price the user is willing to pay, whether he wants the document permanently or merely wishes to borrow it for a time, etc. It is recommended that in all cases if possible users approach a library first to enquire as to the best method for obtaining documents.

Nevertheless, wherever possible, a source code has been given with each citation under the heading "Available from". The following is a list of addresses for each of these source codes, along with any special ordering procedures where applicable and price information where available.

APOA
APOA Information Service
P.O. Box 1281
Station "M"
Calgary, Alberta T2P 2L2

Ordering procedure: Include the report number, title, number of copies required and type of copy (microfiche or photocopy).
Prices: Prices shown are effective September 1, 1980 and may be subject to change.

BSRA
Head of Technical Information division
British Ship Research Association
Wallsend Research Station
Wallsend, Northumberland, England

Ordering procedure: Include the citation number given under "Available from". Prices: Photocopies of original reports are vailable at 15 cents per page (minimum charge, 75 cents). Copies of existing translations are available for $20 for the first copy and $2.50 for duplicate copies.

CISTI (Photocopying Service)

Canada Institute for Scientific and Technical Information
Telephone: (613) 993-1585
Price: $2.20 (up to 10 pages), or 22¢ per page for longer articles.

Maritime Administration
Office of Commercial Development
Main Commerce Building
Washington, D.C. 20230

MICROMEDIA
Document Delivery Centre
Micromedia Limited
144 Front Street West
Toronto, Ontario
H5J 2L7
Tel.: (416) 593-5211

NORDA
Naval Ocean Research and Development Activity
NSTL Station
Mississippi, USA 39529

NSFI
Ship Research Institute of Norway
Technical University of Norway
N-7034 Trondheim-NTH, Norway

Ordering procedure: Include citation number given under "Available from".
Prices: Photocopies are available at NKR 3.50 (approximately $0.65 per page at September 1977 currency rates).

NTIS
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Ordering procedure: Include number given under "Available from" and indicate whether microfiche or paper copy desired.
Prices: Prices shown are for paper copies and are effective January 1st, 1980.

SNAME
Society of Naval Architects and Marine Engineers
One World Trade Center
Suite 1369
New York, N.Y. 10048

TDC LIBRARY, MONTREAL
Transportation Development Centre
Library
1000 Sherbrooke St. W.
Montreal, Quebec
Tel.: (514) 283-4008

Ordering procedures: Documents are available on interlibrary loan basis only. Contact your local library for assistance.

TC LIBRARY OTTAWA (PHOTOCOPYING SERVICE) OR (INTERLIBRARY LOANS)
Transport Canada
Library and Information Centre
Tower C, Place de Ville
Ottawa, Ontario K1A 0N5
Tel.: (613) 992-4529

Prices: Cost recovery basis

NOTE: The Transport Canada Library and Information Centre, Ottawa will also perform computerized bibliographic services for the marine community on a cost-recovery basis.

Where specific ordering information has not been included, and where the user is not affiliated with a library that can perform document location services for him, the following guidelines are provided.

(a) Reports, Conference Proceedings, Books (Monographic publications)

Where the user wishes to purchase the item concerned he can approach the published or corporate source for information concerning availability and price. (Place and name of publisher or corporate source are given in the citation following the title of the document).

Where the document is not available for purchase or the user would prefer to borrow the item, the Canada Institute for Scientific and Technical Information (CISTI) will lend directly to the user (for up to two weeks) any books, reports or conference proceedings contained in their collection.

In addition, since CISTI is the primary clearinghouse for the location of monographic publications in science and technology, they will provide alternative library locations for such items not contained in their collection. Once these alternative locations are found, the user must approach a public or other library to act as the borrowing intermediary to obtain the documents on interlibrary loan. (These alternative library locations do not have the mandate to serve the public directly and must be approached through a borrowing library).

Address and telephone number of CISTI are as follows:

Canada Institute for Scientific and Technical Information
National Research Council of Canada
Building M-55, Montreal Road
Ottawa, Ontario
K1A 0S2
Tel.: (613) 993-1585

(b) Journal articles, individual conference papers

There are very often numerous library locations for journals and the user is advised to approach a local library for assistance. Although CISTI (see list of source codes given on previous pages) will in many cases have the journal in question, they have not always been listed as the source since a local library may be able to provide the document required. It should be noted that journals cannot be borrowed — individual articles can be obtained as photocopies or reprints.

Similarly individual conference papers are often available from the publisher only as part of the complete conference proceedings. In these cases the entire proceedings can be purchased or borrowed as indicated in (a) above or a photo reproduction of the individual paper can often be obtained from the holding library. CISTI will provide this service for items in their collection on the same pricing basis as for journal articles.

(c) Newspaper articles

Back copies of newspapers are often held by university or public libraries either in paper copy or microfiche.

(d) Translations

A number of foreign-language articles have been included. It should be noted that unless the item has been identified as a translation, the source given will provide the document in the original language. It is possible that some of these articles have in fact been translated into English or French. To determine if an English or French translation exists the user is referred to the CISTI translation service (Canadian Index of Scientific Translations) which can be reached at (613) 993-3372. This service locates translations in Canada, the United States, the United Kingdom and several other countries.

Source List — Unpublished Material

The following organizations contributed unpublished material.

Memorial University

Esso Resources Canada Ltd.

Gulf Canada Resources Inc.

Canadian Arctic Resources Committee

Petro Canada

Melville Shipping Ltd.

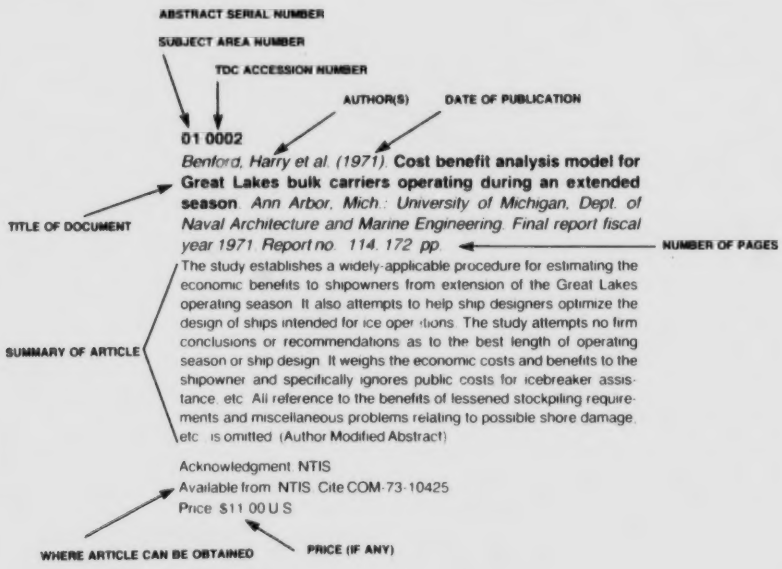
Arctec Canada Ltd.

Ice Engineering Ltd.

Cold Regions Research and Engineering Laboratory

Bibliographic Format

The standard form of reference to an article, report, standard etc. is shown below:


ABSTRACT SERIAL NUMBER
SUBJECT AREA NUMBER
TDC ACCESSION NUMBER
AUTHOR(S)
DATE OF PUBLICATION
01 0002
Benford, Harry et al. (1971). Cost benefit analysis model for Great Lakes bulk carriers operating during an extended season. Ann Arbor, Mich.: University of Michigan, Dept. of Naval Architecture and Marine Engineering. Final report fiscal year 1971. Report no. 114. 172 pp.
TITLE OF DOCUMENT
NUMBER OF PAGES
SUMMARY OF ARTICLE
The study establishes a widely-applicable procedure for estimating the economic benefits to shipowners from extension of the Great Lakes operating season. It also attempts to help ship designers optimize the design of ships intended for ice operations. The study attempts no firm conclusions or recommendations as to the best length of operating season or ship design. It weighs the economic costs and benefits to the shipowner and specifically ignores public costs for icebreaker assistance, etc. All reference to the benefits of lessened stockpiling requirements and miscellaneous problems relating to possible shore damage, etc., is omitted. (Author Modified Abstract)
Acknowledgment: NTIS
Available from: NTIS. Cite COM-73-10425
Price: $11.00 U.S.
WHERE ARTICLE CAN BE OBTAINED
PRICE (IF ANY)

Accession Number

The accession number given to various reports and articles in this bibliography contain six numbers. The first two digits designates the subject area given in the following Categories; numbering from 01 to 13. The remaining four numbers have been assigned by Transportation Development Centre to assist organizations in ordering of documents and ease of reference.

Categories

Topics covered by subject areas:

01 **Economic Aspects**

02 **Ice Accretion and Control**

03 **Ice Breaking, Ice Transit Operation and Methods**

04 **Ice Collision Damage, Shipwreck and Trapped Vessels**

05 **Ice Navigation — General**

06 **Model Testing, Simulation Studies, Etc.**

07 **Navigational Aids and Data Gathering (On-Board)**

08 **Propulsion Systems and Technology**

09 **Research Facilities, Policies and Programs**

10 **Ship Trials and Performance**

11 **Ship/Ice Interaction (Including Offshore Structures)**

12 **Vessels — Description and Design Information**

13 **Related Bibliographies**

Request for Other Reports

Readers are requested to furnish comments and forward information that will assist others in the area of work: this cooperation will enhance the usefulness of the bibliography. All material is to be sent to Transportation Development Centre, Transport Canada, 1000 Sherbrooke St., W., Montreal, Quebec, H3A 2R3.

01 Economic Aspects

01 0001

Albery, Pullerits, Dickson & Associates. (1978). **A study of marine transportation of oil and LNG from Arctic islands to southern markets**. *Don Mills, Ontario: Albery, Pullerits, Dickson & Associates. 4 vols. (Canada. Ministry of Transport. Report no. TP 1531)*

The present study assesses probable costs on a commercial basis. Although it gives a fair indication of the economic feasibility of the marine transportation of oil and LNG from the Arctic Islands, it does not include a rigorous market analysis which depends on future energy prices and is outside the Terms of Reference. In conclusion it may be said that the study indicates that the transportation of oil and LNG from the Arctic Islands by a predominantly marine route is technically feasible but the marketing of gas at an acceptable profit may depend on policy decisions and future changes in the OPEC price of oil and gas. The main advantage of a predominantly marine transportation system is that it provides the opportunity to develop arctic island oil and gas in increments, starting with a much smaller threshold quantity than possible with a pipeline. (Author)

Acknowledgement: ASTIS
Available from: TDC Library, Montreal (Interlibrary loan)

01 0002

Benford, Harry et al. (1971). **Cost benefit analysis model for Great Lakes bulk carriers operating during an extended season**. *Ann Arbor, Mich.: University of Michigan, Dept. of Naval Architecture and Marine Engineering. Final report fiscal year 1971. Report no. 114. 172 pp.*

The study establishes a widely-applicable procedure for estimating the economic benefits to shipowners from extension of the Great Lakes operating season. It also attempts to help ship designers optimize the design of ships intended for ice operations. The study attempts no firm conclusions or recommendations as to the best length of operating season or ship design. It weighs the economic costs and benefits to the shipowner and specifically ignores public costs for icebreaker assistance, etc. All reference to the benefits of lessened stockpiling requirements and miscellaneous problems relating to possible shore damage, etc., is omitted. (Author Modified Abstract)

Acknowledgment: NTIS
Available from: NTIS: Cite COM-73-10425
Price: $11.00 U.S.

01 0003

Callis, S. et al. (1974). **Great Lakes winter navigation. Technical and economic analysis. Volume II. Computer program. Documentation and user instruction**. *Ann Arbor, Mich.: University of Michigan, Dept. of Naval Architecture and Marine Engineering. 316 pp.*

This volume in a series of reports provides user instructions and documentation for the Extended Season Program (ESP) developed under sponsorship of the Maritime Administration. The program analyzes the costs and benefits accruing to a Great Lakes shipowner in operating an individual vessel in the bulk trades in an extended shipping season. The program can deal with a large variety of ship types, shipping routes, and conditions of winter environment.

Acknowledgement: NTIS
Available from: NTIS: cite PB-270984/8ST Also Volume 1: PB-270983 Paper copy set of 6 reports. PC E13, PB-270982 SET

01 0004

Cowley, J.E. (1976). **Quantitative application of ice climate data to winter navigation studies**. *Canadian Journal of Civil Engineering 3 (2): 229-238.*

In a study of the feasibility of developing a marine terminal at Grande Ile, Quebec, in the St. Lawrence Estuary, the economic influence of winter ice conditions on shipping schedules was estimated. Passage time statistics were estimated by numerical simulation of the passage of vessels from the Atlantic Ocean to this site for the full range of conditions which have been observed. By these calculations the severity of ice conditions was expressed in the terms of delay. The distribution of risk of delay over the winter season and the probabilities of total delay affecting cargo inventories were derived. A program of data gathering to improve the empirical basis of the speed loss estimate is suggested.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" item (b).

01 0005

Culshaw, S.T. (1977). **An examination of marine transport in the ice season off the Labrador and North Newfoundland Coasts**. *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions, Memorial University of Newfoundland, St John's, Nfld., September 26-30, 1977, pp. 425-439. St John's, Nfld.: The University, Ocean Engineering Information Centre, 1978. 16 pp.*

Governments have been exploring further afield, into more remote areas, in search of raw materials and fossil fuels. One of these areas is Labrador and its offshore Continental Shelf. The latter, for a major part of the year, is covered with sea ice in addition to having an annual pilgrimage of icebergs down the Labrador current. The problem may be defined as, how to move a vessel to and from the Labrador Coast with safety and efficiency all year round. Bearing in mind that the ice cover only exists for part of the year, the economics of the permanent use of icebreakers and/or icebreaker cargo ships is therefore brought into question. This paper gives an overview of the ice problem, examines past observations and in the light of experience, examines the possible approaches for future observations and research, bearing in mind that many have mooted the idea that a specifically constructed vessel can be built to deal with one kind of ice. Is this the case in Offshore Labrador?

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" item (a)

01 0006

Faylor, Robert and Samuel Fishbein. (1973). **Arctic marine commerce study. Volume I: report**. *Washington, D.C.: Arctic Institute of North America. Final report. 333 pp.*

The Arctic Institute of North America, under the sponsorship of the Department of Commerce, Maritime Administration, and with the help of

industrial and Alaskan communities, performed a comprehensive study to determine the future requirements for Arctic Marine Commerce. These requirements establish a basis for prediction of and planning for all aspects of marine commerce in the Alaskan Arctic to the year 2000. In developing these requirements, the study was quantitative and analytical, with emphasis on important and practical economic and social values.

Acknowledgement: NTIS
Available from: NTIS: cite COM-73-12002/4 Also in paper copy as 3-volume set. Cite COM-73-12001-SET
Price: $18.00 U.S.

01 0007

Gordienko, P.A. (1973). **Ways of increasing the profitability of Arctic navigation**. *Problems of the Arctic and Antarctic Vols. 36-37: 174-181.*

Available from: See Introduction "Availability of documents" item (b)

01 0008

Halebsky, M., M. Lebovits and R.M. Romley. (1978). **A preliminary feasibility study of a tanker transportation system serving the Northwest Coast of Alaska**. *Final report — Executive summary. Newport Beach, Calif.: Global Marine Development Inc. 40 pp.*

This study investigated marine transportation systems for transporting crude oil and methanol on a year-round basis from the northwest coast of Alaska to ports on the West Coast of the lower 48 states. The technical and economic feasibility of various transportation systems was parametrically investigated and the results are described in this three-part final report. Part 1, is the Executive Summary, presenting a brief description of the total study. Briefly, the study found that year-round transportation of crude oil is technically feasible and economically attractive. Year-round methanol transportation is also technically feasible, but delivered costs would not be competitive with prevailing market conditions. New construction of ice breaking tankers, or of ice strengthened tankers associated with special icebreaking ships, would be required.

Acknowledgement: NTIS
Available from: NTIS: cite PB80-153638
Price: $6.00 U.S.

01 0009

Kaldjian, M. (1973). **Ice strengthening of Great Lakes ore carriers — a computer-aided analysis**. *Ann Arbor, Mich.: University of Michigan, Dept. of Naval Architecture and Marine Engineering. Report no. 138. 24 pp.*

The object of the study is to establish a widely applicable procedure for estimating the economic benefits to ship owners by extending the Great Lakes operating season in the movement, essentially, of pelletized iron ore. A computer program calculates the additional steel weights necessary to reinforce a vessel for ice.

Acknowledgement: Engineering Index
Available from: NTIS: cite COM-73-10932

01 0010

Kaldjian, M.J. and K.N. Huang. (1974). **Great Lakes winter navigation: technical and economic analysis. Volume V: ice strengthening of ship hulls using steel, ferrocement or reinforced concrete**. *Ann Arbor, Mich.: University of Michigan, Dept. of Naval Architecture and Marine Engineering. Report no. 155. 28 pp.*

Extension of the navigation season on the Great Lakes necessitated finding the added weight and cost of ice strengthening the hull of existing or proposed ships. Using the American Bureau of Shipping rules Section 29, "Strengthening for Navigation in Ice", a design method is developed and a computer program prepared that calculates and compares the added weights and costs of reinforced cement along a ships hull using steel, ferrocement or reinforced concrete for different ice classes and various other parameters.

Acknowledgement: MRIS
Available from: Michigan University, Ann Arbor College of Engineering, Ann Arbor, Michigan

01 0011

Kotras, T. (1975). **Winter rate study for Great Lakes-Saint Lawrence Seaway system: volume 1**. *Columbia, Md.: ARCTEC Inc. Final report. Report no. 00246-C-3. 123 pp.*

This study is phase 2, part B of the Great Lakes-St. Lawrence Seaway Navigation System Study. Objectives were twofold: (1) to estimate total transit time for ships navigating the Great Lakes-St. Lawrence Seaway system during a winter season and translate these times into vessel operating costs and annual freight rates for major commodity routes, and (2) to estimate effect on these annual freight rates of improvement levels, length of navigation season, winter severity, and vessel fleet mix. A computer model of Great Lakes-St. Lawrence Seaway was developed. It was concluded that all-year navigation on the Great Lakes-St. Lawrence Seaway is commercially feasible. Annual freight rates would decrease for laker bulk cargo routes, but increase for overseas routes. Ships which would benefit most from season extension would be the larger, more powerful and more economical ships. Contractor recommends that the overall Great Lakes-St. Lawrence Seaway system model planned for Phase 3 of this study be developed.

Acknowledgement: NTIS
Available from: NTIS: cite AD-A021 210/OGA
Price: $9.00 U.S.

01 0012

Kotras, J., J. Jacobi and R. Voelker. (1980). **Ship designs for maximizing utilization of Great Lakes waterways: volume I: executive summary**. *Columbia, Md.: ARCTEC Inc. Final Report. Report no. 465C-3-Vol-1. 25 pp.*

This volume comprises the Executive Summary of a study undertaken for the U.S. Maritime Administration to develop an Implementation Plan for the Great Lakes aimed at achieving a five-year goal of increased annual cargo throughput per ship for new vessels at lower transportation costs per ton. Specifically, the five-year goal was to increase annual cargo throughput by 10%, based on a conventional 1,000 ft vessel operating during an eight-month, open-water season, while also lowering transportation cost per ton. As part of this study, ship design criteria for extended season navigation on the Great Lakes and the associated economics were determined. Also, a sensitivity study on the economic impact of variations in the following design parameters was performed: diesel prime mover type and horsepower, fuel prices, ship length, operating draft, open-water speed, and extended season operations.

Acknowledgement: NTIS
Available from: NTIS: cite PB80-183411
Price: $5.00 U.S.

01 0013

Lakes shippers ship out a longer season. *(1971). Business Week 2163 (February 13): 50-51.*

The winter of 1970-71 saw some successful efforts in the direction of extending the shipping season on the Great Lakes. The possibility of future year-round navigation promises substantial financial gains in numerous spheres. Numerous problems are besetting NEWS (Navigation Extension Winter Service) in its project to extend the Lakes shipping season. Discussed are such problems as insurance rates, lock operations, extended Coast Guard duties, political considerations, opposition from Eastern and Southern port interests, and technological

problems. The actual battling of ice is being tried with Finnish methods using bow propellers, air jets, trim conditions and bubble-producing machines. The basic idea of the article is, however, to discuss the monetary obstacles and rewards to shippers, steel companies, iron ore suppliers, and the midcontinent region as a whole.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" item (b)

01 0014

Liddle, L.F. and W.N. Burrell. (1975). **Problems in the design of a marine transportation system for the Arctic**. *Arctic 28(3): 183-193.*

Available from: See Introduction "Availability of documents" item (b)

01 0015

Nowacki, H. (1973). **Great Lakes winter navigation: technical and economic analysis**. *Ann Arbor, Mich.: University of Michigan, Department of Naval Architecture and Marine Engineering. Report nos. 151-156. 6 vols.*

The six volumes present analyses and details of computer programs (Vol. 2) which predict the feasibility of Great Lakes winter navigation under a variety of ice conditions and ship hull reinforcement configurations (Vol. 4 and 5) and power plant upgradings (Vol. 3). The economic ramifications (Vol. 3) of these variations form a major consideration of the programs. Since delays en route or in port represent a critical factor in Great Lakes shipping, a number of these are included in the programs to determine specific economic impacts.

Acknowledgement: CRREL
Available from: NTIS: cite PB-270-982-SET

01 0016

Nowacki, Horst., H. Benford and A. Atkins. (1973). **Economics of Great Lakes shipping in an extended season**. *Ann Arbor, Mich.: University of Michigan, Dept. of Naval Architecture and Marine Engineering. Interim report. Report no. 139. 93 pp.*

The object of the study is to establish a widely applicable procedure for estimating the economic benefits to ship owners by extending the Great Lakes operating season in the movement, essentially, of pelletized iron ore. Each ship on the Great Lakes must be studied for an appropriate extension of service, and an analytical procedure was developed to determine the best length of yearly operation for specific ships. Certain ship characteristics are reviewed for possible means of extending the shipping season.

Acknowledgement: NTIS
Available from: NTIS: cite COM-73-10930
Price: $8.00 U.S.

01 0017

Paris, R. and M. Guay. (1978). **Comparative study of a ferry service by air cushion vehicle and ice-strengthened ferry between Matane, Baie Comeau, Godbout: summary report - Étude comparée d'un service de traversiers maritime par aéroglisseurs et traversiers brise-glace Matane, Baie Comeau, Godbout: rapport sommaire**. *Montreal, Quebec: SNC Consultants Ltd. 23,22 pp. (Canada. Ministry of Transport. No. TP 1883)*

The study was prepared in three stages. Initially, the technical, operational and financial characteristics of the proposed craft, (large size air cushion vehicles and ice-strengthened ships with 200 and 300 car capacity) were analysed. The second phase considere ' the shore installations required and the modifications that could be performed on existing facilities. Environmental implications were looked at and a cost evaluation was established. Finally, for the period 1983-88, an economic analysis examined the costs associated with each of the options studied. Three operating scenarios were developed and used to quantify the operating costs in as realistic an environment as possible. They are based on the annual and monthly traffic for 1977 and on the daily load experienced through the first 7 months of 1978. The constraints that must be observed by the operator, "La Société des Traversiers", were taken into account. These scenarios give an indication of the costs that the operator would have to support for:

1) offering an air cushion vehicle service between Matane and Godbout.
2) adding a 200-car ice-strengthened ship, and
3) adding a 300-car ice-strengthened ship. (Author modified abstract) (DS)

Available from: TDC Library, Montreal (Inter-library loan)

01 0018

Porter, T.J. (1977). **Economic analysis of an Arctic icebreaking tanker transportation system: nuclear vs. fossil**. *(M.S. Thesis, Pennsylvania State University, 1977). 108 pp. University Park, Pa.: The University.*

The author compares the movement of crude oil from the North Shore using conventional fossil fueled tankers vs. nuclear powered icebreakers including transshipment at an ice-free port on the east coast. The study points out the economic competitiveness of the nuclear icebreaking tanker transportation system. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-A073585/2GA

01 0019

*Ryden-Johanson, I. (1974). Ekonomiska aspekter pa vintersjofart i Bottenviken. [***Economic aspects of winter navigation in the Gulf of Bothnia***.] Styrelsen for Vintersjofartsforskning. Forskningsrapport, 1974-No. 7: p. 13-23. (In Swedish.)*

Available from: See Introduction "Availability of documents" items (b) and (d)

01 0020

Semi-submersible icebreaking tanker. *(1975). Ocean Industry 10(10): 38-40.*

A fleet of semi-submersible icebreaking tankers may provide the most economical means of moving crude oil and similar bulk materials through the ice-licked Arctic seas. This was one of the conclusions drawn by a five-year study made by the Aker Group of Oslo, Norway, which was released recently at the third international conference on Port and Ocean Engineering Under Arctic Conditions (POAC) at the University of Alaska. Briefly reviews general design considerations, propulsion, stability, icebreaking capability and a comparative cost analysis between a conventional icebreaking tanker and the SSIT.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" item (b)

01 0021

*Slobozhaninov, IU. IA. (1972). Proizvoditel'nost' lineinykh ledokolov. [***Operating efficiency of leading icebreakers***.] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1972-Vol. 138: p. 71-81. (In Russian.)*

Available from: See Introduction "Availability of documents" items (b) and (d)

01 0022

Swift, P.M. and H. Benford. (1975). **Economics of winter navigation in the Great Lakes and St. Lawrence Seaway**. *New York, N.Y.: Society of Naval Architects and Marine Engineers. Report no. 12. 13 pp. Paper presented at the Annual Meeting, New York, November 13-15, 1975.*

Economic Aspects

The recent achievement of year-round navigation on the Great Lakes makes pertinent a survey of shipowners' costs and benefits resulting from that development. Success on the Lakes also provides new evidence of the probable benefits of parallel extensions of the season in the St. Lawrence Seaway. Following general discussions of the pros and cons of winter navigation, the paper describes the analytical techniques developed by the authors for predicting the economics of extending the operating season both on the Lakes and through the Seaway. The probable economic benefits accruing to each of several kinds of ships are shown. In the case of Great Lakes bulk carriers, the effect of changes in each of several key parameters (for example, bow shape, severity of winter, and ship ice class) is also shown. In addition to economics, the impact of ice navigation on energy utilization is estimated, and possible environmental dangers are considered. Overall, it is concluded that commercial users of Great Lakes and Seaway ships have strong incentives to encourage year-round navigation. Shipowners, while seeming to benefit less than their customers, also have good reason to move in the same direction.

Acknowledgement: SNAME

Available from: SNAME

01 0023

Tsoi, L.G. et al. (1979). Vybor ekonomicheski tselesoobraznoi skorosti transportnykh sudov ledobogo plavaniia. ***[Selecting economically feasible velocity of transport ships designed for ice navigation.]*** *Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1979-Vol. 241: p. 74-78. (In Russian.)*

Available from: See Introduction "Availability of documents" items (b) and (d)

01 0626

Northern Associates (Holdings) Ltd. (1973). **Arctic resources by sea.** *Montreal, Quebec: Northern Associates. 1 vol. Report prepared for Canada. Ministry of Transport.*

Available from: TDC Library, Montreal (Interlibrary loan)

01 0627

Malaurie, Y. (1978). L'exploit de l'Arktika au pôle. Conséquences géo-économiques. ***[Voyage of the Arktika to the Pole and its geoeconomical implications.]*** *Inter-nord 15: 205-208. (In French with English Summary).*

Acknowledgement: CRREL

Available from: See Introduction "Availability of documents" item (b)

02 Ice Accretion and Control

02 0024

Andreev, N.D. (1973). **Cracked ice removal from ship hulls.** *Soviet Inventions Illustrated Section 3 Mechanical and General. 1973-U (29): p. T4. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" item (b)

02 0025

*Avrutov, E.A. (1976). Vliianie stepeni gidrofobnosti naruzhnoi poverkhnosti na teplovoi rezhim raboty tokoprovodiashchego antiobledenitel'nogo pokrytiia. [***Effect of water repellency of a ship's external surface on heat regime of an anti-icing current-conducting layer.***] Problemy Arktiki i Antarktiki Sbornik statei. 1976-Vol. 48: p. 75-84. (In Russian.)*

Available from: See Introduction "Availability of documents" item (b) and (d)

02 0026

Baroarson, H.R. (1973). **Icing of ships.** *In Proceedings of the Second International Conference on Port and Ocean Engineering under Icing Conditions, August 27-30, 1973. pp. 185-202. Reykjavik, Iceland: Iceland University, Dept. of Engineering and Science.*

Reviews the meteorological factors influencing icing as well as rigging and superstructure design which produces the least ice accumulation. Discusses development of icing forecasts incorporated in regular weather forecasts for Icelandic waters. Ship losses due to loss of stability and IMCO criteria for fishing vessels is included. Methods and equipment to reduce danger from icing are recommended. Paper available only as part of the complete Proceedings of the Second International Conference on Port and Ocean Engineering Under Arctic Conditions (POAC). August 27-30, 1973.

Acknowledgement: MRIS

Available from: Iceland University Department of Engineering and Science Reykjavik, Iceland

02 0027

Bordovitsyn, IU.A., N.IA. Matusevich and S.I. Nakhamkin. (1972). **Separating water droplets from air to prevent icing up in maritime gas-turbines etc.** *Soviet Inventions Illustrated Section 3 Mechanical and General. January 1972: p. B11-B12. Patent. (English.)*

Available from: See Introduction "Availability of documents" item (b)

02 0028

Borisenkov, E.P. (1974). **Investigation of the physical nature of ship icing.** *Arlington, Va.: Cold Regions Research and Engineering Lab. Joint Publications Research Service. Report no. CRREL-TL-411. 189 pp. (Translation).*

The report, the third in a series on the problem of ship icing, pertains to the investigation of the physical nature of icing. Topics discussed include hydrometeorology, ice adhesion, adhesion reducing coatings, deicers and marine ice dielectric properties.

Acknowledgement: NTIS

Available from: NTIS: cite AD/A-003 215/1ST

Price: $12.00 U.S.

02 0029

Borisenkov, Ye P. and I.G. Pchelko. (1975). **Indicators for forecasting ship icing** *Metodicheskie ukazaniia po preduprezhdeniiu ugrozy obledeniia sudov. Hanover, N.H.: Cold Regions Research and Engineering Lab. Report no. CRREL-TL-481. 65 pp. (Translation).*

The USSR Hydrometeorological Center has twice published "Tentative Instructions on Warning of a Possible Icing of Ships" (in 1967 and 1969) and each time, the instructions were subjected to verification under the conditions of the actual operation of the forecasting agencies of our service. In all the four cold seasons, the USSR Hydrometeorological Center received more than 3,000 questionnaires concerning the icing of ships. The Hydrometeorological Service also collected and collated the observational data concerning the icing of ships. On the basis of the data indicated above, the third "Procedural Instructions" was published. By comparison with the previous publications of "Tentative Instructions", this version has been considerably revised and supplemented. The section on estimating the wave action which was included in this second publication has now been eliminated since in the recommendations given on the estimation and prediction of icing, wave action has been disregarded.

Acknowledgment: NTIS

Available from: NTIS: cite no. AD-A030 113/SST

Price: $7.00 U.S.

02 0030

*Borisevich, K. (1976). Peredacha lotsmana v ledovykh usloviiakh. [***Relief of pilots under ice conditions.***] Morskoi flot, 1976-No. 1: p. 35. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" item (d)

02 0031

*Buianov, N.F. (1967). Kak borot'sia s obledeneniem sudov. [***How to fight icing of ships.***] Rybnoe khoziaistvo, 1967 - No. 2: p. 30-32. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" item (d)

02 0032

*Buianov, N.F. (1971). Iz opyta raboty srednetonnazhnykh promyslovykh sudov v usloviiakh obledeneniia. [***Experience in operating medium-tonnage fishing boats under icing conditions.***] In Teoreticheskie i eksperimental'nye issledovannia uslovii obledeneniia sudov (Theoretical and experimental studies of ship icing): p. 98-107. (In Russian.) Leningrad: Gidrometeoizdat, 1971.*

Available from: See Introduction "Availability of documents" item (a) and (d)

02 0033

*Buianov, N.F., V.A. Kokaev and G.K. Naumov. (1971). O rezul-'tatakh nabliudenii za obledeneniem sudov v prikromochnoi zone Beringova moria v 1971/71 g. [***Observing ship icing near the ice-edge zone of the Bering Sea in 1971-72.***] Leningrad. Arkticheskii i antarkticheskii nauchno-issledovatel'skii institut. Trudy, 1975-Vol. 317: p. 144-151. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" item (d)

02 0034

*Churakov, L.IA., V.K. Savinykh and R.N. Bobrov. (1976). Snegouborochnye i vymorozochnye raboty v parokhodstvakh Sibiri. [***Snow and ice removal methods used for steamships in Siberia.***] Novosibirsk. Institut inzhenerov vodnogo transporta. Trudy, 1976-Vol. 94: p. 3-8. (In Russian.)*

Available from: See Introduction "Availability of documents" item (b) and (d)

02 0035

*Churakov, L.IA., B.IA. Stazhevskii and A.G. Iuferov. (1976). Teoriia raboty mekhanicheskogo tsentrobezhnogo udarnogo ustroistva. [***Working principle of a mechanical centrifugal impact device.***] Novosibirsk. Institut inzhenerov vodnogo transporta. Trudy, 1976-Vol. 94: p. 71-77. (In Russian.)*

Available from: See Introduction "Availability of documents" item (b) and (d)

02 0036

DeAngelis, Richard M. (1974). **Superstructure icing.** *Washington, D.C.: National Oceanic and Atmospheric Administration. Environmental Data Service. Report no. NOAA-74012309-1. 8 pp.*

Freezing sea spray is by far the most common and dangerous form of icing. It can occur when the air temperature falls below the freezing temperature of seawater (usually about -2C) and sea-surface temperatures are below about 5C. If air temperature falls below about -18C, wind-induced spray may freeze before striking the ship and not adhere. In general, however, the lower the temperature and the stronger the wind, the more rapid the accumulation of ice. Superstructure icing can occur in the cold water seas of both hemispheres, from fall through spring. Moderate icing potential exists when temperatures fall to -2C or below and winds blow at 13kt or more. This means a probable accumulation of up to about 3 in. per hour. The potential for severe icing (greater than 3 in. per hour) exists when temperatures are -9C or lower, and winds are 30 kt or more.

Acknowledgement: NTIS
Available from: NTIS: cite COM-74-90018-01-01

02 0037

De-icing apparatus for ships. *(1970). Polar Record 15(96): 343-344.*

Available from: See Introduction "Availability of documents" item (b)

02 0038

De-icing equipment for trawlers. *Sea Harvest and Ocean Science 23-25 (Dec. '69- Jan. '70): n.p.*

Available from: See Introduction "Availability of documents" item (b)

02 0039

Evdokimov, S.I., V.I. Kashtelian and V.K. Kovalenko. (1974). **Jet compressors for navigating ship in ice.** *Soviet Inventions Illustrated Section 3 Mechanical and General 1974 - V(15): p. T4. Patent. (English abstract.)*

Available from: See Introduction "Availability of documents" item (b)

02 0040

Gurvich, L.E. (1974). **On comparison of actual ice burden of commercial fishing vessels with standards of USSR Register.** *CRREL Report TL-411: pp. 140-152. Hanover, N.H.: U.S. Army Cold Regions Research and Engineering Laboratory. (Translation).*

Available from: See Introduction "Availability of documents" item (a)

02 0041

*IAkovlev, G.N. (1971). Razrushenie l'da reaktivnoi gazovoi struei. [***Breaking ice with a jet of gas.***] Leningrad. Arkticheskii i Antarkticheskii nauchno-issledovatel'skii institut. Trudy, 1971-Vol. 300: 153-167. (In Russian.)*

Use of gas jet for ice cutting, deicing of roads, airports, etc.

Available from: See Introduction "Availability of documents" item (b) and (d)

02 0042

Icing danger poses threat to Seaway. *Globe & Mail. Report on Business, 11 December 1975: B5.*

Available from: See Introduction "Availability of documents" item (c)

02 0043

Icing of ships — a Soviet view. *(1968). New Scientist 37(585): 404-405.*

Available from: See Introduction "Availability of documents" item (b)

02 0044

Ivanov, L.C. and S. Vinogradov. (1972). **Ice removal from ships bottom.** *Soviet Inventions Illustrated Section 3 Mechanical and General April 1972: p. E14. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" item (b)

02 0045

Kilgour, R. and W.K. Brown. (1973). **Degradation of communication on Awf whip antennas in an icing environment at sea.** *Portsmouth, Eng.: Admiralty Surface Weapons Establishment. Report no. TR-73-4; BR36594. 65 pp.*

Atmospheric conditions conductive to icing at sea are outlined, and the probable nature of the resulting ice accretion is discussed. The effects of saline ice accretion on communication efficiency of whip antennas, typically used in current Fishery Protection vessels, are assessed from measurements made on a representative antenna in the BAC Climatic Chamber in a simulated moderately severe icing environment. Communication efficiency is shown to be badly degraded by virtue of power dissipation in ice bridging the base insulator, and by the creation of an appreciable mismatch between transmitter and antenna. Some palliative measures are discussed and recommendations made to alleviate the situation. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite N-74-14909/7
Price: $8.50 U.S.

02 0046

Kolosova, N.V., V.V. Panov and M.IA. Zatonskii. (1971). O metodike sostavleniia kart veroiatnosti obledeneniia sudov dlia

arkticheskikh morei. [**Procedure for compiling charts of ship-icing probability in Arctic seas.**] *In Teoreticheskie i eksperimental'nye issledovvannia uslovii obledeneniia sudov (Theoretical and experimental studies of ship icing): p. 194-204. (In Russian.) Leningrad: Gidrometeoizdat, 1971.*

Available from: See Introduction "Availability of documents" item (a) and (d)

02 0047

Kuznetsov, V.P. (1971). Vliianie obledeneniia na ostoichivost' sudna. [**Effect of icing on the stability of ship.**] *In Teoreticheskie i eksperimental'nye issledovaniia uslovii obledeneeniia sudov (Theoretical and experimental studies of ship icing): p. 77-86. (In Russian.) Leningrad: Gidrometeorizdat, 1971.*

Available from: See Introduction "Availability of documents" item (a) and (d)

02 0048

Lock, G.S.H. (1972). **Some aspects of ice formation with special reference to the marine environment.** *Transactions of the North East Coast Institution of Engineers and Shipbuilders 88(6): 175-184.*

This study is an attempt better to understand the thermal and dynamic characteristics of atmospheric icing in general and accretion on seaborne vessels and navigational aids in particular. Consideration is given to the rather scattered literature on atmospheric icing, including recent studies on hailstones and aircraft, in order to develop a consistent physical description of the icing process. The relevant non-dimensional parameters are disclosed. A detailed series of wind tunnel experiments is reported. Some comments are made on various techniques for controlling shipboard ice.

Acknowledgement: Engineering Index
Available from: CISTI (Photocopying service)

02 0049

Matthews, P. (1969). **British-made de-icing gear is effective safety feature.** *National Fisherman 50(2): 29A.*

Available from: See Introduction "Availability of documents" item (b)

02 0050

Morimura, Shinji. (1972). **Studies on the ice accumulation on ships. III. On the prevention of icing on ships by membranous water.** *Hokkaido Daigahu Suisangakubu Kenkyo Ibo 23(1): 29-38.*

Available from: See Introduction "Availability of documents" item (b) and (d)

02 0051

Nechaev, IU. (1967). Avariia SRT "Boksitogorsk" v usloviiakh intensivnogo obledeneniia. [**Wreckage of the "Boksitogorsk" due to intensive icing.**] *Morskoi flot, Jan. 1967 No. 1: p. 25-27. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" item (d)

02 0052

Ono, N. (1964, transl. 1968). **Studies of ice accumulation on ships. II. conditions of icing and accreted ice weights.** *Ottawa: National Research Council Canada. Technical translation 1968-TT-1319. 14 pp.*

Available from: CISTI (Photocopying service)

02 0053

Ono, N. (1973). **Loss of ships due to icing.** *Polar News 9(1): 31-36. (In Japanese.)*

Available from: See Introduction "Availability of documents" item (b) and (d)

02 0054

Osvobozhdenie sudna ot sloia l'da s pomoshch'iu potokoobrazovatelia. [**Flow-forming device for removing ice layer from ships.**] *Biulleten' tekhniko-ekonomicheskoi informatsii, June 1970 No. 6: p. 26. (In Russian.)*

Available from: See Introduction "Availability of documents" item (b) and (d)

02 0055

Paniushkin, A.V. et al. (1972). Rezul'taty ispytanii nekotorykh sredstv bor'by s obledeneniem v naturnykh usloviyakh. [**Results of field tests of anti-icing methods.**] *Leningrad. Arkticheskii i antarkticheskii naucno-issledovatel'skii institut. Trudy, 1972-Vol. 298: p. 91-96. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" item (d)

02 0056

Panov, V.V. (1978). **Icing of ships.** *Polar Geography 2(3): 166-186.*

The problem of icing of ships, mainly from sea spray formed during strong wave motion or as a combination of precipitation and spray is discussed. Icing poses a threat in ice-free seas rather than in drift ice, and the highest frequency has been observed in the Barents Sea, at the western end of the Arctic shipping route, and in the Bearing Sea and Sea of Okhotsk, at the eastern end, the most common period being Dec. through Mar. In the central portion of the Arctic (Kara, Laptev, East Siberian and Chuckchee seas), icing poses a problem in the summer shipping season (June through Nov.). Icing conditions are analyzed on the basis of Soviet and non-Soviet observations. (AM)

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" item (b)

02 0057

Parfenov, A.F., V.V. Balanin and L.V. Ivanov. (1973). **Effect of ice on ships and structures and maintenance of their operation at sub-zero air temperatures.** *In International Congress of Navigation, 23rd. Report, Section II, Subject 4, pp. 165-200. Brussels, Belgium: Permanent International Association of Navigation Congresses, 1973.*

Available from: See Introduction "Availability of documents" items (a) and (b)

02 0058

Parsons, R.C. and R.M. Hopkins. (1977). **Chemical method for ice destruction.** *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions, Memorial University of Newfoundland, St. John's, Nfld., September 26-30, 1977, V. 2, pp. 799-810. St John's, Nfld.: The University, Ocean Engineering Information Centre, 1978.*

A novel method for ice destruction is described in which ice is reacted with such gases as ammonia, hydrogen chloride, sulfur dioxide or volatized ammonium chloride. The associated equipment to deliver these reactants to the ice is very simple consisting only of nozzles, tanks, pressure regulating valves and hose. Using this equipment and ammonia as a reactant gas, drilling rates up to 210 cm/min. have been

achieved. Because of the "salting effect" which occurs when the reactant gas dissolves in the melt water, refreezing is minimized. A wide range of applications for the method have been identified. These include drilling in ice bergs for the placing of explosive charges or for the setting of anchor bolts for towing, deicing of ship superstructures, deicing of canal locks and the reduction of friction between the hull of an ice breaker and the ice surface.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" items (a) and (b)

02 0059

Petherick, V.C. (1970). **An assessment of ice loadings on the aerial outfits AKE2 and AKE4.** *Portsmouth, Eng.: Admiralty Surface Weapons Establishment. Technical report. Report no. ASWE-TR-70-7. 22 pp.*

It is expected that ice will form on the AKE2 and AKE4 array at mast head height under certain arctic conditions. An assessment of the accretion rate on the open mesh type structure, which forms the major part of this aerial's construction was carried out under controlled environmental conditions. The investigations showed that a maximum ice loading of 2032 kg (2 tons) could be expected on the aerial and a wind load of 4064 kg (4 tons) could be obtained when the fully iced array was trained into storm force winds. The only method found of reducing these loadings was to train the array such that the ends or smallest areas were presented to the elements. The additional loadings imposed on the array are unlikely to affect the structure as the design specification loadings for this aerial are far in excess of those due to ice and wind. It was also shown that excessive amounts of ice formed in the reflector horns and this is expected to degrade the radar performance appreciably early on in the build up cycle. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-714 520
Price: $5.00 U.S.

02 0060

*Rozentsveig, V.B. (1971). Vliianie obledeneniia na morekhodnost' i ostoichivost' promyslovykh sudov. [***Effect of icing on seaworthiness and stability of fishing boats.***] In Teoreticheskie i eksperimental'nye issledovannia uslovii obledeneniia sudov (Theoretical and experimental studies of ship icing): p. 70-76. (In Russian.) Leningrad: Gidrometeoizdat, 1971.*

Available from: See Introduction "Availability of documents" items (a) and (d)

02 0061

*Rybnikov, B.N. (1975). Analiz unikal'nogo sluchaia obledeneniia srednego rybolovnogo traulera "Piarnu". [***Analysis of a unique case of icing of the medium fishing trawler "Piarnu".***] Leningrad. Arkticheskii i antarkticheskii nauchno-issledovatel'skii institut. Trudy, 1975-Vol. 317: p. 132-140. (In Russian.)*

Relation between ship velocity, icing intensity and hydrometeorological factors.

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" item (d)

02 0062

Sawada, T. (1973). **Ice accretion on ships on the line from North America to Japan.** *Hakodate Marine Observatory. Bulletin 17(8): n.p. (In Japanese.)*

Available from: See Introduction "Availability of documents" items (b) and (d)

02 0063

Seminar on Trawler Safety. Operations and Maintenance of Deep-Sea Trawlers under Arctic Conditions. *A Seminar Held at the Admiralty Surface Weapons Establishment and the Admiralty Experiment Works on 23rd June 1970. Orpington, England: Naval Scientific and Technical Information Centre, 1971. 72 pp.*

Contents: Ice accretion on ships; Icing and De-icing of distant water trawlers; model testing; Recommendations on intact stability of fishing vessels; Icing on radar and communication aerials; The icing and de-icing of marine radar aerials; De-icing methods and engine noise reduction; Manoeuvring of small ships at slow speed; Seakeeping. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-728 903
Price: $7.00 U.S.

02 0064

Shekhtman, A.N. (1971). **Hydrometeorological conditions in the icing-up of vessels at sea.** *Orpington, Eng.: Naval Scientific and Technical Information Centre. Report no. NSTIC-29541; NSTIC-Trans-2311. 22 pp.*

A survey is given of literature about the icing-up of vessels and the results of a summary of several hundred factors concerning this dangerous occurrence and the accompanying hydrometeorological conditions. The circumstances of icing-up are defined more accurately, and recommendations for the further study of hydrometeorological factors which influence the icing-up of vessels are given. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-723 591
Price: $5.00 U.S.

02 0065

Shekhtman, A.N. (1971). **The probability and intensity of the icing-up of ocean-going vessels.** *Orpington, Eng.: Naval Scientific and Technical Information Centre. Report no. NSTIC-Trans-2312; NSTIC-29795. (Translation).*

The paper discusses the various factors leading to the formation of ice on ship structures.

Acknowledgement: NTIS
Available from: NTIS: cite AD-727 849
Price: $5.00 U.S.

02 0066

Shellard, H.C. (1974). **The meteorological aspects of ice accretion on ships.** *Geneva, Switzerland: World Meteorological Organization. Marine Science Affairs Report no. 10. 34 pp.*

This report is primarily a review of literature on the subject of ice accretion on ships. It discusses the main types of icing experienced at sea, their causes and relative importance together with the effects of icing on ships and in relation to individual meteorological elements. Methods of reporting and forecasting the phenomenon are also discussed. Marine Science Affairs Report No. 10.

Acknowledgement: MRIS
Available from: Unipub, Box 433, Murray Hill Station, New York, N.Y. 10016

02 0067

*Shvaishtein, Z.I. (1971). Bor'ba s obledeneniem podvodnykh konstruktsii sudna. [***Preventing ice accumulation on submerged parts of a ship.***] In Teoreticheskie i eksperimental'nye issledovannia uslovii obledeneniia sudov (Theoretical and experimental studies of ship icing): p. 124-133. (In Russian.) Leningrad: Gidrometeoizdat, 1971.*

Available from: See Introduction "Availability of documents" items (a) and (d)

02 0068

Smirnov, I.A. (1974). **Icing rate of small-capacity fishing vessels under various hydrometeorological conditions.** *Meteorologiia i Gidrologiia 3: 50-60. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" item (d)

02 0069

*Smirnov, V.I. (1971). Raschetnye znacheniia predelov prochnosti namerzaiushchego l'da pri obledenenii sudov. [***Design values of strength limits of ice accumulating on ships.***] In Teoreticheskie i eksperimental'nye issledovaniia uslovii obledeneniia sudov (Theoretical and experimental studies of ship icing), p. 154-158. (In Russian.) Leningrad: Gidrometeoizdat, 1971.*

Available from: See Introduction "Availability of documents" items (a) and (d)

02 0070

Stallabrass, J.R. (1970). **Methods for the alleviation of ship icing.** *Ottawa, Ont.: National Research Council of Canada. Division of Mechanical Engineering. Mechanical engineering report. Report no. DME-MD-51. 36 pp.*

Tests were made, both in an icing wind tunnel and at an outdoor test site, of various proposals for the alleviation of the problem caused by the freezing of sea spray on the superstructures of ships. Of the devices evaluated, a pneumatic de-icing technique proved the most effective under all conditions for the de-icing both of masts and of flat surfaces such as bridge fronts. Next in effectiveness was the use of ethylene glycol as a freezing point depressant to reduce the strength and adhesion of the ice. Several passive methods were tried, but none was very effective, with the exception of a plastic foam with an outer layer of neoprene rubber. (Author)

Acknowledgement: NTIS

Available from: NTIS: cite AD-721 960

Price: $6.00 U.S.

02 0071

Stallabrass, J.R. (1971). **Meteorological and oceanographic aspects of trawler icing off the Canadian East Coast.** *Marine observer 41(233): 107-121.*

Available from: CISTI (Photocopying service)

02 0072

Stallabrass, J.R. (1975). **Icing of fishing vessels in Canadian waters.** *National Research Council of Canada. Quarterly Bulletin of the Division of Mechanical Engineering and the National Aeronautical Establishment DME/NAE 1975(1): 25-43.*

To effectively combat the icing problem it is first necessary to have a thorough understanding of its causes and the physical processes involved as well as an awareness of the true extent of the hazard. This paper presents a review of the present knowledge of these processes. The conditions necessary for ship icing are generally accepted (but with some disagreement as to precise limits) to be the simultaneous occurrence of air temperature of minus 2 degree C or lower, water temperature of plus 6 degree C to minus 2 degree C, and wind speed greater than 20 knots. In addition the vessel's speed and heading relative to the wind and sea must be such as to produce significant amounts of spray over the vessel. If atmospheric precipitation, fog or sea smoke prevails in addition to sea spray, the combined effect is to produce more severe icing than would result from one source alone.

Acknowledgement: Engineering Index

Available from: CISTI (Photocopying service)

02 0073

Stallabrass, J.R. (1979). **Icing of fishing vessels: an analysis of reports from Canadian east coast waters.** *National Research Council Canada. Division of Mechanical Engineering. Report June 1979-LTR-LT-98. 23 pp.*

Available from: CISTI (Photocopying service)

02 0074

*Stazhevskii, B.IA. and N.N. Monzyrev. (1976). Issledovanie raboty konicheskoi frezy l'doskalyvatelia. [***Performance of the conical cutter of an ice removal device.***] Novosibirsk. Institut inzhenerov vodnogo transporta. Trudy, 1976-Vol. 94: p. 26-39. (In Russian.)*

Available from: See Introduction "Availability of documents" items (b) and (d)

02 0075

Swan, K.T. (1977). **Survey of icing conditions for marine gas turbines.** *[S.l.]: U.S. Naval Air Propulsion Test Center. Report no. NAPTC-PE-114. 70 pp.*

Available from: See Introduction "Availability of documents" item (a)

02 0076

*Vinogradov, E.S. et al. (1974). Sredstva zashchity dnishcha sudna oto l'da i metody bor'by s obledeneniem pri dokovanii sudov. [***Means of protecting ship's bottom from ice damage and its body from icing during docking.***] Moscow. 51 p., (In Russian with abridged English table of contents enclosed.)*

Available from: See Introduction "Availability of documents" items (a) and (d)

02 0628

Lundguist, J.E. and I. Udin. (1977). **Ice accretion on ships with special emphasis on Baltic conditions.** *Helsinki, Finland: Winter Navigation Research Board. Research report no. 23. 32 pp.*

Acknowledgement: OEIC

Available from: OEIC: cite no. E05732

02 0629

Stallabrass, J.R. (1980). **Trawler icing. A compilation of work done at N.R.C. National Research Council Canada,** *Division of Mechanical Engineering. 103 pp. (National Research Council Canada, Mechanical Engineering Report MD-56).*

Acknowledgement: OEIC

Available from: OEIC

03 Ice Breaking, Ice Transit Operation and Methods

03 0077

*Anosov, A.V. and A.D. Didyk. (1969). Upravlenie sudnom i ego tekhnicheskaia ekspluatatsiia. [***Navigation and technical operation of a vessel.***] Moscow: Transport. 483 pp. Pertinent pages 378-398. (In Russian.)*

Available from: See Introduction "Availability of documents" Item (a)

03 0078

Antonov, V.S. and I.I. Poznyak. (1968). **Prospects for using river icebreakers on the lower reaches of large Siberian rivers.** *Arkticheskii i Antarkticheskii nauchno-issledovatel'skii institut. Trudy 283: 157-164. (In Russian.)*

The Ob, Yenisey and Lena are free of ice and suitable for navigation for only a short time and the period differs somewhat in the upper and lower parts of the river. Powerful icebreakers operate in the open sea and in the estuaries. Smaller icebreakers can operate in the rivers but their maintenance for short-time use in sping and fall is not economic. A new method is used in the lower reaches of rivers, which consists of breaking the ice cover by the pitching of the icebreaker.

Acknowledgement: MRIS

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0079

Armstrong, T. (1979). **Soviet capabilities in Arctic marine transport.** *In Proceedings of the Symposium on Marine Transportation and High Arctic Development: Policy Framework and Priorities, Montebello, Quebec, March 21-23, 1979, pp. 210-222. Ottawa: Canadian Arctic Resources Committee.*

This article reviews Soviet ice-breaking activities, especially by the nuclear ships of the fleet, for the 1978 season, and speculates on the increasing trend of Soviet passage through the northern sea route. An implication of Soviet capabilities is the possible use of Canadian Arctic waters for Soviet navigation.

Acknowledgement: ASTIS

Available from: See Introduction "Availability of documents" Items (a) and (b)

03 0080

Aronson, R.B. (1973). **How Northern Europe breaks the ice.** *Machine Design 45(1): 18-20.*

A description is given of various methods of icebreaking that are employed by European vessels during their winter months of operation. These methods include the use of a "bubbler" system, the incorporation of icebreaking capabilities into some of the ships, and even the utilization of vibrations that are sent through the hull to break up the ice. These methods are fully described, as is the Wartsila model tank, which has an ice-making capability, and is extensively used in the development of icebreaking vessels.

Acknowledgement: MRIS

Available from: See Introduction "Availability of documents" Item (b)

03 0081

Ashton, G.D. (1974). **Evaluation of ice management problems associated with the operation of a mechanical ice cutter on the Mississippi River.** *Hanover, N.H.: Cold Regions Research and Engineering Laboratory. Report no. SR 214. 37 pp.*

The study concentrates on effects occurring after the cutting operation. Included in the evaluation are assessments of refreezing rates, movement and disposition of the slabs produced by the cutting, and an examination of effects related to ice jams. The evaluation is specific to the upper Mississippi River, in particular Pool 19 above Lock and Dam 19 at Keokuk, Iowa. It was found that most ice production during a winter occurs during a small fraction of the period of ice cover hence removal after these short periods may allow navigation to proceed for significant wintertime periods. A relation was found between cut slab dimensions and critical velocity to move them that will enable estimates to be made of accumulation. Breakage of adjacent ice by vessel waves was found to impose a possible restraint on vessel speed but not a serious one.

Acknowledgement: CRREL

Available from: See Introduction "Availability of documents" Item (a)

03 0082

Ashton, G.D., S.L. Den Hartog and B. Hanamoto. (1973). **Icebreaking by tow on the Mississippi River.** *Hanover, N.H.: Cold Regions Research and Engineering Lab. Special report. Report no. CRREL-SR-192. 77 pp.*

A field investigation of icebreaking by the motor vessel Renee G, operating on the Mississippi River between Alton, Il, and Fort Madison, IA, is reported. The operation encountered a wide variety of ice conditions and was performed with a variety of barge configurations and arrangements. Important qualitative observations of the nature and difficulties encountered while icebreaking were made; and, by instrumenting the propeller shafts and using load cells between the towboat and the barges, quantitative information was obtained on the resistance encountered while icebreaking. Also described are the effects of repeated passage through an ice cover, navigation procedures peculiar to icebreaking, and minor damage sustained by the towboat. (Author)

Acknowledgement: NTIS

Available from: NTIS: cite AD-768169/5

03 0083

*Auberger, J.F. and J. Verlet. (1975). Préparation du PELICAN à la campagne du Labrador. [***Preparation of the PELICAN for cruises in Labrador.***] In Fifth International Congress of the Fondation française d'études nordiques, Le Havre, France, May 2-5, 1973, no. 12, pp: 263-267. Paris: École pratique des hautes études. Centre d'études arctiques, 1975. (In French.)*

Available from: See Introduction "Availability of documents" Items (a) and (b)

03 0084

*Babain, V. (1968). Vybor distantsii mezhdu ledokolom i sudnom pri ledokol'nykh provodkakh. [***Choosing the distance**

between the icebreaker and the ship following it. *] Morskoi flot, 1968-No. 1: p. 15-16. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0085

Bach, H.A. (1979). **Thrusters increase maneuverability.** *Offshore 39 (February 1979): 166-167.*

Available from: See Introduction "Availability of documents" Item (b)

03 0086

Backman, A. (1977). **Experiences from directing icebreakers and winter navigation.** *Paper presented at the Symposium on Ice, Ships and Winter Navigation, [Oulu University, Finland], December 16-17, 1977.*

Swedish icebreaking operations in the Baltic Sea and on Lake Vaenern are described. The acquisition of information on ice conditions and ship movements is discussed, and the directing of icebreakers to sites where they are needed is dealt with.

Acknowledgement: NSFI

Available from: NSFI: cite No. 19952

03 0087

*Balanin, V.V. et al. (1967). Prokhodimost' transportnykh sudov i Ledokolov v shuge. [***The ability of cargo vessels and icebreakers to make way in frazil ice.** *] Rechnoi transport 26(12): 47-48.*

Considers the navigability of these vessels in frazil, slush, or brash ice, or any combination of them. The interaction of frazil with the hull and the driving-steering mechanism of a vessel depends on the composition and intensity of the ice, and on the type of driving-steering mechanism, the draft, traction force, running and maneuvering abilities of the vessel, also the presence and distribution of heated compartments along its effective length. Two cases are considered: when the frazil layer is thinner than the draft measure of the vessel, and when it is thicker, as in an ice jam. River icebreakers and tow-boats are considered whose total length of heated hull is about 80% of the vessel's length, and those with 30% of heated length. In frazil ice thinner than the draft of the first-case vessels, their maneuverability and speed diminishes 20-60% when moving downstream, and may reduce to zero when moving against the stream. At places of ice jam, the maneuverability of these vessels is practically zero, and working the second-case (30% heated hull) vessels is impossible. The method of mechanically rolling the vessel to help form a layer of water between the frazil and the hull, thus improving the efficiency of transit is described. Heating the bow and stern of an experimental vessel, in addition to 80% of its length, and rolling the vessel in frazil markedly improved its icebreaking and running performance.

Acknowledgement: Arctic Institute of North America

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0088

Ball, M.A. (1977). **Continuing advances with air cushion icebreaking.** *Ottawa: National Research Council Canada, Associate Committee on Air Cushion Technology. Technical report Jan. 1977-no. 2/77: pp. 105-132.*

Available from: CISTI (Photocopying service)

03 0089

Bastian, C.E.Jr. (1974). **Method of clearing a path through ice.** *Patent, May 7, 1974. U.S. Patent office. 8 pp.*

Available from: Dept. of Consumer & Corporate Affairs Patents Reproduction Unit Place du Portage Hull, Quebec K1A 0C9

Price: $4.00

03 0090

Bates, H.F. and L.H. Shapiro. (1980). **Breaking ice with gravity waves.** *Journal of Energy Resources Technology 102(3): 148-153.*

Available from: CISTI (Photocopying service)

03 0091

Behlke, Charles E. (1970). **Arctic operation and moorage of large ships.** *In American Society of Civil Engineers, Meeting preprint no. 1220. Paper presented at ASCE National Structural Engineering Meeting, Portland, Oregon, April 6-10, 1970. 12 pp.*

Available from: See Introduction "Availability of documents" Item (a)

03 0092

Bennett, J.D. and P.E. Chaney. (1974). **Method of breaking ice.** *Canadian patent No. 947983, May 28, 1974. 12 pp.*

Available from: Micromedia

03 0093

*Bogorodskii, V.V. (1975). Ustanovka dlia razrusheniia lediangogo pokrova akvatorii. [***Breaking-up of ice layer in water basin.** *] Soviet Inventions Illustrated Section 3 Mechanical and General. December 1975 - W(47): No. 442108. Patent. (English abstract.)*

Available from: See Introduction "Availability of documents" Item (b)

03 0094

*Borodkin, B.S. (1965). Sposoby obespecheniia prodlennoi raboty slipov. [***Methods of extending the working period of ships.** *] Trudy koordinatsionnykh soveshchanii po gidrotekhnike, 1965- No. 17: p. 164-173. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0095

Bow washing system will ease big ferry through ice. *(1970). Transactions of the Institute of Marine Engineers 82(1): 16.*

Available from: See Introduction "Availability of documents" Item (b)

03 0096

Breaking the ice with the Russians. *(1976). Canadian Shipping and Marine Engineering 47(11): 22-27.*

Available from: See Introduction "Availability of documents" Item (b)

03 0097

Brigham, Lawson W. (1980). **Underway with the 140-foot icebreaker tugs.** *In United States Naval Institute Proceedings 106(10). n.p.*

Available from: See Introduction "Availability of documents" Item (b)

03 0098

Burton, R. (1977). **Breaking the Arctic ice.** *North 24 (2): 32-35.*

Available from: See Introduction "Availability of documents" Item (b)

03 0099

Buzuev, A.IA. et al. (1979). Uchet vliianiia ledianogo pokrova pri vybore optimal'nogo vida ledokol'noi provodki morskikh sudov. ***[Allowing for ice cover effect when selecting an optimal way of ice navigation with icebreakers.]*** *Leningrad. Tsentral-'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy. 241: 66-74. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0100

Clark, A.F. (1973). **Ability of a CO_2 laser to assist ice breakers.** *Applied Optics 12 (June 1973): 1103-1104.*

Available from: See Introduction "Availability of documents" Item (b)

03 0101

Coburn, J.L., Jr. and N.A. Ehrlich. (1973). **Advanced icebreaking concepts.** *Naval Engineers Journal 85(4): 11-19 [24?].*

Recent economic studies have resulted in favorable predictions for extending winter navigation in domestic waterways. The Coast Guard is attempting to meet this challenge by taking a "fresh look" at icebreaking and applying new and innovative concepts to accomplish its task. This paper describes three advanced concepts which have been investigated: materials handling, explosive icebreaker, and the "super efficient" River Ice Breaker (RIB) concept, which has been selected for continued development. The paper concludes with statements about conventional icebreakers and why R&D is now being applied to enhance U.S. icebreaking technology.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (b)

03 0102

Coveney, D.B. and W.H. Brierley. (1979). **Cutting cold river ice with water jets during the winter 1977-78.** *Ottawa, Ontario: National Research Council Canada. 24 pp.*

Available from: See Introduction "Availability of documents" Item (a)

03 0103

Crane, C.L., Jr. (1979). **Shiphandling in Arctic ice based on experience with the MANHATTAN.** *In Proceedings of the Third Annual CAORF [Computer-aided Operations Research Facility] Symposium, Maritime Simulation Research, King's Point, N.Y., October 15-16, 1979. Paper no. 17. King's Point, N.Y.: National Maritime Research Center. 4 pp.*

As suggested by the Symposium organizers, comments given in this mini-paper are abstracted from some written observations on icebreaking which the author made 10 years ago during Manhattan's N.W. Passage trip, and 9 years ago at the Helsinki Ice Model Basin. The first set of notes which are quoted were written on September 17, 1969 after the Manhattan had completed her west bound transit of the Canadian Arctic from Baffin Bay to Point Barrow, Alaska. It had not yet made the eastbound voyage through hardening new winter ice. The observations remained generally valid, however. Manhattan had been mainly assisted by the Canadian Coast Guard Icebreaker John A. MacDonald. The paper consists of five paragraphs under the following headings and are based on visual observations until that date: 1) Following Leads and Polynyas; 2) Turning in Thin Ice; 3) Turning in Thick Ice While Breaking Continuously; 4) Turning in Ramming Mode, Including When Backing; 5) Design considerations for Maneuvering. This paper touches briefly on some aspects of maneuvering a large icebreaking tanker in Arctic ice and the results of some subsequent model tests. Both occurred about 10 years ago. Additional data that were obtained at that time have been given to MarAd, and Arctec has been retained to digest and report them. Therefore, if additional details are required on any of the subjects mentioned, these can probably best be handled by contacting Arctec or MarAd directly. Exxon is, of course, happy to attempt to answer questions where necessary.

Acknowledgement: MRIS
Available from: Maritime Administration

03 0104

Cykin, E.N. (1970). **Use of the ice channeling plow for the prevention of ice barrages.** *Ottawa, Ont.: Defence Scientific Information Service. Report no. T-543-R. 7 pp. (Translation).*

The development of the ice channeling plow promises a considerable simplification of the task of ice barrage prevention at points on a river where ice transit is impeded. There now appears a real possibility of eliminating dangerous ice barrages on our major rivers or in the head regions of non-transfluent forebays or reservoirs. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-714 413
Price: $5.00 U.S.

03 0105

Evdokimov, S.I., V.I. Kashtelian and V.K. Kovalenko. (1973). **Ensuring ship's passage through ice.** *Soviet Inventions Illustrated Section 3 Mechanical and General 1973-U27: p. T2-3. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

03 0106

Fighting ice. *(1978). Ocean Industry 13(10): 144-146.*

Research efforts of the Arctic Petroleum Operators' Association are discussed in connection with a project that studied crater, bench, and controlled splitting blasting as well as blasting in water under ice. The project also endeavored to develop a lightweight shothole drill for placing charges, to determine load factors for ice during bench blasting, and to ascertain if ice islands become unstable under shock loading. Crater blasting is the best way to destroy ice islands, and placing charges under ice is the best method for destroying ice sheets in rivers and lakes. Techniques used in blasting ice islands are outlined. A slurry explosive with a 1.45 specific gravity in a 29 ft. diameter spherical cavity is recommended. Bench blasting and controlled splitting need too much explosive to be effective. Ice destruction can also be affected through the use of such gases as ammonia, hydrogen chloride, sulfur dioxide and volatized ammonium chloride. This method is intended for small scale applications and includes the following operations: drilling holes in icebergs to allow the anchoring of a towing system; the drilling of a cavity for explosive demolition of icebergs; deicing of surface areas on ships; and the slotting of ice sheets for such projects as pipelaying and deicing of canal locks. The salting effect on water produced when using the gas destruction method prevents refreezing. More development work is still needed for this method but researchers are convinced of its effectiveness.

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

03 0107

Fokeev, V. (1969). Razrushenie l'da dlia tselei sudokhodstva. ***[Ice breaking for navigation purposes.]*** *Rechnoi transport, 1969 - No. 4: p. 45-46. (In Russian.)*

Electrical water-ejecting device with a strong hydraulic stroke, mounted on ship's bow, for breaking ice-blocks 6.5 x 2.6 x 0.8 meters. Its productivity was 347 cu m per hour, making 6 shots per minute. One series of six shots makes a hole 2.6 m wide and 0.5 m deep. The cost of breaking one cu m of ice was 6 kopecks.

Acknowledgement: CRREL
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0108

German, J.G. (1971). **Bulk shipping and icebreaker support in the Arctic**. *In Arctic Transport: Proceedings of the Arctic Transportation Conference, Yellowknife, N.W.T., 8-9 December 1970, Vol. 3(4). Ottawa: Information Canada.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

03 0109

Goettel, F.A. (1979). **Topics on shiphandling in ice**. *In Proceedings of the Third Annual CAORF [Computer-aided Operations Research Facility] Symposium, Maritime Simulation Research, King's Point, N.Y., October 15-16, 1979, Paper no. 19. 5 pp. King's Point, N.Y.: National Maritime Research Center.*

It is apparent that there is more than one point of view from which to examine the problems of ice navigation. This paper does not present the viewpoint of the scientist/engineer but examines the problem as seen from the bridge by the navigating personnel. Outlines the problems encountered when navigating in ice encumbered waters. The most common measures currently used to cope with these problems are discussed briefly. Possibilities for the future are suggested.

Acknowledgement: MRIS
Available from: Maritime Administration

03 0110

Guthridge, G.G. (1975). **Operating in Antarctic waters**. *Oceanus 18(4): 32-35.*

Despite such obstacles as icebergs, sea ice, cold, and wind, research and supply ships routinely penetrate the pack ice and reach open waters adjacent to the Antarctic continent. Beyond 60S ice-strengthened ships such as (Islas Orcadas), formerly (Eltanin), and (Hero) are needed to penetrate pancake ice or loose pack. Icebreakers, which are also used regularly as research platforms, are required in denser pack. In addition to special facilities for research, most icebreakers carry helicopters and boats. Photographs of vessels operating in Antarctic waters and some typical ice conditions are shown.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Item (b)

03 0111

Hints on ice navigation. *(1976). Ship and Boar International 29(12): 31*

Available from: See Introduction "Availability of documents" Item (b)

03 0112

Hope, A.A., et al. (1980). **Air cushion icebreaking bow development program, 1975-1978**. *Montreal, Que.: Transport Canada Research and development centre. Summary report 1975-1978. Report no. TP 1924. 72 pp.*

This report summarizes the activities undertaken in a four year program to develop an air cushion platform as an icebreaking device attached to a ship's bow (i.e. low speed icebreaking method).

The conventional approach to improve icebreaking capability is to increase the power and weight of the ship and to improve the hull shape. The objective of this program was to improve that capability by attaching an air cushion platform (icebreaking bow) to the ship. The development program includes mathematical analysis, scale modelling, economic analysis and two winters of full scale testing in Thunder Bay, Ontario. Results showed that: a) attaching an air cushion icebreaking platform to the bow of a ship in intact uniform ice cover appreciably enhances the ship's ability to penetrate the ice cover; and b) this method of breaking a given area of ice achieves considerable savings.

Further development is required to optimize the design of air cushion icebreakers in terms of size and application. Mathematical models were devised, but validation by experimental data was not achieved. Such predictions are the most cost effective means on which to base future designs of air cushion icebreakers for operation in Canada, including the Arctic.

Available from: Transportation Development Centre, Montreal

03 0113

Icebreaker rams to Nanisivik. *(1978). Canadian Mining Journal 99(9): 14.*

Available from: See Introduction "Availability of documents" Item (b)

03 0114

Ivanov, V.M., M.V. Pekhtusov and I.A. Titov. (1971). **Icebreaker channel improvement**. *Soviet Inventions Illustrated Section 3, Mechanical and General August 1971: p. 8E. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

03 0115

*Katunin, M. (1968). Osobennosti plavaniia sredi aisbergov. [***Navigating among icebergs***.] Morskoi flot, May 1968 No. 5: p. 19. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0116

KIISLA: an ice breaking products tanker designed for safe, year-round navigation. *(1974). Marine Engineers Review (June): n.p.*

A description of Finland's domestic oil refining company's operations in the ice covered Finnish Archipelago using a ten-vessel fleet of ice strengthened ships consisting of crude carriers, products tankers and harbor icebreakers.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (b)

03 0117

Koblov, I.T. (1972). **Cutting of passages through floating ice fields**. *Soviet Inventions Illustrated Section 3 Mechanical and General January 1972: p. E6. Patent. (English.)*

Available from: See Introduction "Availability of documents" Item (b)

03 0118

Lauren, B. (1972). **Grooved icebreaking with air** *[***M-S "Finncarrier"***.] Ball Bearing Journal 172: 9-10.*

Available from: See Introduction "Availability of documents" Item (b)

03 0119

Lecourt, E.J. and R.P. Voelker. (1974). **Evaluation of mechanical ice cutter concept for use in domestic icebreaking service**. *Columbia, Md.: ARCTEC Inc. Final report Sept. 73 - Jan. 74. 184 pp.*

The report analyzes requirements for Coast Guard support in various domestic waterways and applies the mechanical ice cutter (MIC) concept to meet these requirements. Use of the MIC on the Mississippi River to support winter commerce is treated in exhaustive detail and to a greater extent than other areas. (Modified author abstract)

Acknowledgement: NTIS
Available from: NTIS: cite AD-775 988/9
Price: $12.00 U.S.

03 0120

Lee, Christopher L. (1980). **Diary of an icebreaker.** *In United States Naval Institute Proceedings 106(10). n.p.*

Available from: See Introduction "Availability of documents" Item (b)

03 0121

Levanov, B. (1979). Rabotat' v ledovykh usloviiakh. **[Navigation under ice condition.]** *Rechnoi transport, 1979 No. 10: 5-6. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0122

Lilly, K.E., Jr. and J. Stewart. (1977). **Arctic Alaska north slope resupply operations.** *Mariners Weather Log 21(1): 8-12.*

Available from: See Introduction "Availability of documents" Item (b)

03 0123

McDonald, E.A. (1965). **Polar shiphandling.** *Washington, D.C.: Arctic Institute of North America. 60 pp.*

Available from: See Introduction "Availability of documents" Item (b)

03 0124

Mellor, M. (1974). **Cutting ice with continuous jets.** *In Proceedings of the International Symposium on Jet Cutting Technology, 2nd, Cambridge, England, April 2-4, 1974, Report no. MP 731, pp. G5/65-76.*

The practicality of cutting ice with continuous water jets has been investigated by laboratory experiments and field tests, using nozzle pressures from 2500 to 100,000 lbf/sq. in (17.2 to 690 MN/sq. m), traverse speeds from 0 to 357 ft/min (0 to 1.8 m/sec), and nozzle diameters from 0.008 to 0.023 in. (0.203 to 0.584 mm). Special emphasis has been given to a study of the feasibility of using water jets to supplement the performance of icebreaking vessels. While the "non-contact" aspect of a jet tool is attractive, power requirements for deep penetration at high traverse speeds are exorbitant by comparison with the power requirements for competing cutting systems. Application of test data in design calculations for other cutting applications is discussed.

Acknowledgement: CRREL

Available from: See also Introduction "Availability of documents" Items (a) and (b)

03 0125

Mellor, M. (1979). **Towing ships through ice-clogged channels by warping and kedging.** *Hanover, N.H.: Cold Regions Research and Engineering Laboratory. Report no. CRREL-79-21. 21 pp.*

The report studies the question of whether Great Lakes freighters could move effectively through ice-clogged channels with the aid of tows provided by warping or kedging systems. Ten operational concepts are outlined, and their advantages and disadvantages are noted. The crushing resistance of floating brash ice is then analyzed. The neutral, active and passive states of stress for laterally confined brash ice are considered, and the resistance to horizontal thrusting by a smooth vertical wall is calculated for cohesionless brash ice, and for ice in which there is finite cohesion between the ice fragments. The thickening of the ice cover in the vicinity of a "pusher" and the formation of pressure ridges are analyzed in order to estimate the amount of pile-up that can occur against a ship hull. The analysis then moves on to consideration of ship resistance by brash ice, taking into account crushing resistance at the bow, tangential friction at the bow, and the hull friction aft of the bow section. Comparisons are made between thrust from the ship's screws and the calculated ice resistance. The next section of the report estimates the force requirements for a warping or kedging system in terms of thrust augmentation for existing vessels. Tow cable requirements are given, and estimates are made for cable anchors and for anchorage of underwater structures. The force and power requirements for winches and windlasses are given, the practical problems involved in the pickup or transfer of cables are mentioned, and the report concludes with a brief appraisal. The conclusion is that a simple warping tug system is appropriate for a full-scale experiment, a chain ferry with auxiliary barge seems attractive for an operational system, and a chain ferry plow may be an efficient way to clear ice from channels.

Acknowledgement: NTIS

Available from: NTIS: cite AD-A077 801/9

Price: $6.00 U.S.

03 0126

Mellor, Malcolm. (1980). **Icebreaking concepts.** *Hanover, N.H.: Cold Regions Research and Engineering Lab. Special report. Report no. CRREL-SR-80-2. 23 pp.*

Icebreaking concepts that have potential application in the protection of offshore structures and drillships are reviewed. The concepts dealt with include conventional icebreaking by ships, icebreaking by air cushion vehicles, breaking against fixed structures, mechanical cutting with drag bit tools, blasting by high explosives, blasting with compressed gases or propellants, ice melting, thermal cutting, cutting with lasers, cutting with high pressure water jets, and unproven novel concepts. Special emphasis is given to the specific energy requirements for the various methods. (Author)

Acknowledgement: NTIS

Available from: NTIS: cite AD-A082 175/1

Price: $5.00 U.S.

03 0127

Mellor, Malcolm and Austin Kovacs. (1971). **Breakage of floating ice by compressed gas blasting.** *Hanover, N.H.: Cold Regions Research and Engineering Lab. Final report. 56 pp.*

The report presents information on a feasibility study of compressed gas blasting for use as a potential method of disengaging sea ice around beset ships. (author)

Acknowledgement: NTIS

Available from: NTIS: cite AD-730 303

Price: $7.00 U.S.

03 0128

Mellor, Malcolm and Austin Kovacs. (1972). **Breakage of floating ice by compressed gas blasting.** *Hanover, N.H.: Cold Regions Research and Engineering Lab. Special report. Report no. CRREL-SR-184. 46 pp.*

Tests were made to determine the effectiveness of compressed-gas blasting devices for breaking floating ice sheets. Experiments were made on frozen lakes in New Hampshire and Alaska using the Cardox and Airdox blasting systems, and comparative tests were made with conventional chemical explosives. Gas blasting devices were found to be closely comparable to chemical explosives in terms of specific energy consumption, but absence of any significant shock wave in the gas blast results in a different mode of action. The gas devices fractured the ice largely by flexure, giving large fragments. Practical applications of gas blasting for ice breaking are discussed. (Author)

Acknowledgement: NTIS

Available from: NTIS: cite AD-755 504

Price: $6.00 U.S.

03 0129

Mellor, Malcolm and Francis Gagnon. (1973). **Cutting ice with**

high pressure water jets. *Hanover, N.H.: Cold Regions Research and Engineering Lab. Final report. 22 pp.*
The report describes high pressure water jet ice cutting experiments conducted in support of the Coast Guard domestic icebreaking program. The test objectives were to determine power requirements for cutting two feet of fresh water ice at a speed of advance of 5 knots. The results of the tests show extremely high power requirements even when using state-of-the-art equipment pumping at 100,000 psi. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-766 172/1
Price: $5.00 U.S.

03 0130
*Metelev, S. and R. Agalakov. (1971). Ledokol'nyi kater na splave. [***Ice breaking boat used in timber floating**.*] Lesnaia promyshlennost', May 1971 No. 5: p. 14. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0131
Muller, E.R. (1979). **Icebreaking with an air cushion vehicle**. *SIAM Review 21 (January 1979): 129-135.*

Available from: See Introduction "Availability of documents" Item (b)

03 0132
*Murzin, A.I. and A.A. Romanov. (1977). Osobennosti ledovoi provodki sudov v usloviiakh poliarnoi nochi. [***Ice navigation during the polar night**.*] Problemy Arktiki i Antarktiki, 1977 Vol. 50: p. 85-88. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0133
*Muslin, E. Pushki i led. (1968). [***Guns and ice**.*] Znanie-sila 1968 No. 5: p. 14-15. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0134
Newport News Shipbuilding and Drydock Company. Advanced Systems Design Group. (1970). **North Slope oil and gas transportation study**. *Newport News, Va.: Newport News Shipbuilding and Drydock Company. 45 pp.*
There are several routing schemes for the removal of Alaskan oil. With the exception of the Mackenzie River pipeline, each of the routes includes a sea-leg component. The development of the Mackenzie River scheme would eliminate a sizeable potential ship market, and concern over this possibility prompted a new examination of the Northwest Passage. This examination centered on determination of the more sensitive elements of the proposed all-icebreaker tanker system and the development of more economical alternatives to these sensitive elements. This has resulted in a new system concept, FROST, Floating Repair and Oil Storage Terminal. Where a large icebreaker tanker could average seven to ten knots in the new ice of Baffin Bay, as little as one knot could be expected through parts of the old ice. The economics of the icebreaker system are very sensitive to the average speed through the ice, and current speed estimates practically double the early expected transportation costs by this method. The development of a floating terminal which could move with the seasonal extremes of the Baffin Bay ice grew from the realization that the expensive, highly specialized icebreaker tanker could not operate economically in open water. With a terminal constantly on the edge of the ice pack, the icebreaker could spend practically all of its operational time in the ice. This was the basis for FROST. Having evaluated the effect of FROST on the icebreaker system, its effects on the economics of the even more expensive nuclear submarine system was determined. Here again, FROST would be used for on station docking and maintenance, and tankers of about 120,000 dwt would be used for the East Coast leg. This combination system was evaluated against the General Dynamics proposed system of transferring at a southern Greenland terminal. FROST is capable of docking and making both minor and major repairs with the use of its own shops and crew to either the icebreakers or the submarines. To save docking time, FROST was designed to dock a fully loaded icebreaker and accomplish ballasting up and offloading oil simultaneously. FROST was also designed to include tankage for crude oil storage of 606,000 tons to minimize the criticality of rendevous scheduling. This report provides an economic analysis of the following transport systems: a) icebreakers only; b) icebreakers/FROST and conventional tankers; c) submarines and conventional tankers; d) submarines/FROST and conventional tankers to the East Coast. Study Report by the Advanced Systems Design Group.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (a)

03 0135
Nikolaev, S.E. (1973). **Cutting sea ice by directed blasting**. *Hanover, N.H.: Cold Regions Research and Engineering Lab. Report no. CRREL-TL396. 23 pp. (Translation).*
The use of directed blasting can prove a very effective means in solving a number of practical problems: the creation in the pripay (fast shore ice) of ice-free channels for the passage of ships with a weak hull, for laying pipes or cable from the ice surface, and so forth. Placing the charges according to a prescribed system and exploding them through brief time intervals in a fixed sequence can assure the directed removal of ice along the given direction. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-768 829/4

03 0136
*Ol'shamovskii, S.B. (1971). Sudovozhdenia i pravila plavaniia na vnutrennikh sudokhodnykh putiakh. [***Navigation and rules for inner waterways**.*] Moscow: Transport. 335 pp. Pertinent pages 252-258. (In Russian.)*

Available from: See Introduction "Availability of documents" Item (a)

03 0137
*Opyt provodki rechnykh sudov v ledovykh usloviiakh. [***Experience in ice navigation of river vessels**.*] (1970). Moscow. 36 pp. (In Russian.)*

Available from: See Introduction "Availability of documents" Item (a)

03 0138
Paddison, F.C. and A.M. Stone. (1972). **Transportation in the Arctic**. *Silver Spring, Md.: John Hopkins University, Applied Physics Laboratory. Technical memorandum APL-TG-1190. 101 pp.*

Available from: See Introduction "Availability of documents" Item (a)

03 0140

*Peschanskii, I.S. (1967). Primenenie metodov razrusheniia morskogo l'da. [***Methods of sea ice destruction.***] Problemy Arktiki i Antarktiki, sbornik statei, 1967 Vol. 27: p. 82-92. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0141

Peschanskiy, I.S. (1969). **Breaking the Russian ice**. *New Scientist 41(March): 574.*

Gives some data on dusting, mentions the bubbler system for melting or preventing formation of ice in inland waters and announces the development of two ice-cutters in the USSR. One is for rivers, reservoirs and canals with ice thickness not greater than 0.5 m. The other is for unbroken ice up to 2 m thick. The principle involves making longitudinal cuts by mechanical or hydraulic means before the ice is actually broken up.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (b)

03 0142

Peschanskii, I.S. (1971). **Methods of disrupting an ice cover**. *Hanover, N.H.: Cold Regions Research and Engineering Lab. Report no. TL-240. 63 pp. (Translation).*

For solving the problems in ice technology, it is necessary to resort to the engineering methods of breaking down an ice cover, predetermined by the features of the water basin and the purposes of the tasks which are being conducted. In this report, the following problems are discussed: Disruption of ice cover during cruising of ships in ice; Disruption of ice barriers; Protection of structures and ships; Creation of conditions favoring a delay in the ice formation process; Removing the ice and snow from water basins; and Cutting holes around ships. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-720 073
Price: $7.00 U.S.

03 0143

*Petrov, P. (1973). Sanki vmesto ledokola. [***Sleds instead of icebreakers.***] Izobretatel' i ratsionalizator, June 1973 No. 6: p. 12-13. (In Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

03 0144

*Podanev, F., V. Shuvalov and V. Pimenov. (1975). Shvartovka v ledovykh usloviiakh. [***Mooring in the presence of ice.***] Morskoi flot, 1975 No. 3: p. 34-35. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0145

Quigley, E.J. (1976). **Sealift to Prudhoe Bay**. *Surveyor 10(4): 6-10.*

Nearly 75,000 tons of prefabricated power and processing plant-modules and other needed stores valued at $200 million were transported through the Beaufort Sea by 11 tugs and 21 barges in the Arctic summer of 1976. The voyage began when 2 tugs and 4 barges left Seattle, Washington, July 4, 1976. The convoy was under the command of James DePue of Arctic Marine Freighters, a subsidiary of Crowley Maritime Corporation, San Francisco, California. The convoy sailed 3,200 mi from Seattle on a northwest route across the Pacific Ocean, through the Aleutian Islands at Unimark Pass to the 1st assembly point at Port Clarence in the Bering Sea, 62 mi NNW of Nome. As soon as the ice was sufficiently broken to allow safe passage, the convoy proceeded through the Bering Strait to the next assembly point at Wainwright. From there the convoy sailed to Point Barrow, where the flotilla of tugs made the final run through the Beaufort Sea to Prudhoe Bay. The icebreaker barge Arctic Challenger was towed to Point Barrow for possible use in icebreaking duties at the vanguard of the flotilla. (from Test)

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

03 0146

Robertson, B.W. (1977). **High-speed method of air cushion icebreaking**. *Ottawa: National Research Council Canada, Associate Committee on Air Cushion Technology. Technical report. Jan. 1977. No. 2/77: pp. 133-140.*

Available from: CISTI (Photocopying service)

03 0147

*Rublevskii, M. (1978). V slozhnykh meteouslaviiakh. [***Under severe weather conditions.***] Tyl i snabzhenie Sovetskikh vooruzhennykh sil, July 1978 No. 7: 77-79. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0148

Saunders, A.R., R.V. Hess and R.A. Lucht. (1972). **A technique for breaking ice in the path of a ship**. *Hampton, Vt.: Langley Research Center. Patent application. Report no. NASA-CASE-LAR-10815-1; US-PATENT-APPL-SN-233587. 11 pp.*

A technique is described for breaking ice in the path of a ship. A laser is placed on the bow of the ship with apparatus to scan the ice in the path of the ship with the laser beam. The beam cuts or shatters the ice, enabling the ship to break the ice in its path.

Acknowledgement: NTIS
Available from: NTIS: cite N72-22520
Price: $5.00 U.S.

03 0149

*Sergeev, G.N. (1977). Skorosti dvizheniia sudov vo l'dakh i raschet optimal'nykh sostavov karavanov. [***Speeds of ships navigating in ice and optimal convoy compositions.***] Problemy Arktiki i Antarktiki, 1977 Vol. 50: p. 80-84. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0150

Shnitnikov, IU. (1978). **Soviet icebreaker reaches the North Pole**. *Canadian Geographical Journal 96(1): 34-37.*

Available from: See Introduction "Availability of documents" Item (b)

03 0151

Shvaishtein, Z.I. (1973). **Cutting ice with a continuous high-pressure water jet** *(Rezanie l'da nepreryvymi struyami vysokogo davleniya). Hanover, N.H.: Cold Regions Research and Engineering Lab. Report no. CRREL-TL397. 14 pp. (Translation).*

In a study of the possible techniques of cutting ice by an "icecutter", it was clarified that, in addition to the mechanical devices for cutting and breaking down the ice, it is feasible to utilize a high-pressure water jet. The possibility of the utilization of such jets is particularly important for cutting relatively thick ice (from 0.5 m and more) since the mechanical means (disk cutters, etc.) are fairly complicated. During the movement of the icecutter, from a hydrocompressor mounted on the ship, through

shaped nozzles, we feed continuous high-pressure jets with which a number of parallel blocks are cut.

Acknowledgement: CRREL
Available from: NTIS: cite AD-769 721/2

03 0152
Shvaishtein, Z.I. (1973). **Use of steady high-pressure jets to cut ice.** *Leningrad. Arkticheskii i Antarkticheskii nauchno-issledovatel'skii institut. Transactions (Trudy). Iakovlev, G.N., ed., Ice physics and ice engineering, Vol. 300: p. 148-155. Jerusalem: Israel Program for Scientific Translations, 1973.*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0153
Sinotin, V.I. (1973). **Recommended practice for combatting ice jams.** *Cold Regions Research and Engineering Lab. Hanover, N.H.: Report no. CRREL-TL400. 109 pp. (Translation).*
Contents: Field observations of ice jams and data analysis; Artificial weakening of ice; Mechanical destruction of ice, Artificial ice jams and straightening of channels; Using airplanes to prevent and destroy ice jams; Prevention and destruction of ice jams with explosives; Passage of ice through hydraulic structures during construction and use of hydroelectric stations without ice jam formation; Hydraulic and thermal regulation of water bodies and currents to prevent and combat ice jams.

Acknowledgement: NTIS
Available from: NTIS: cite AD-769 723/8
Price: $10.50 U.S.

03 0154
*Slobozhaninov, IU. IA. (1973). Effektivnost' raboty ledokolov pri provodke sudov. [***Effectiveness of icebreaker performance for ship convoys.***] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy. 1973 Vol. 168: p. 26-43. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0155
*Soler, M. (1972). Ledianye zatory. [***Ice jams.***] Nauka i zhizn' April 1972 No. 4: p. 102-106. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0156
Soviet A-power conquers North Pole. *(1978). Canadian Shipping and Marine Engineering 49(6): 26-29.*

Available from: See Introduction "Availability of documents" Item (b)

03 0157
Sudbury, J.D. (1973). **Submerged barges for Arctic transportation.** *Ocean Industry 8(3): 22-24.*

Available from: See Introduction "Availability of documents" Item (b)

03 0158
*Tavrizov, V.M. (1967). Ledokol'nye vzryvnye raboty. [***Ice blasting work.***] Moskva: Izd-vo Nedra, 1967. 144 pp. (In Russian.)*
Describes the organization, methods, technology, and practical ways of using explosives on ice encountered in inland navigation. Forestalling damage to hydraulic constructions and river vessels by moving ice, the breakup of ice dams and prevention of consequent floods are dealt with. Freeing metal-hull vessels of ice capping their bottoms during winter lay up and/or repairs, the transit of river vessels through ice, construction of hydraulic installations, etc. are discussed. Preparation of ice blasting, determination of the form of the charge and the amount of explosive in it for specific purposes are discussed. Measures are outlined for safety of personnel, and for security of the nearby structures. Examples are given of organizing and carrying out ice blasting to prevent dynamic ice damage to a bridge 240 m long and 14 m high, to a pontoon bridge on metal barges, and to a hydroelectric power plant.

Acknowledgement: Arctic Institute of North America
Available from: See Introduction "Availability of documents" Items (a) and (d)

03 0159
*Telov, V.I. and I.M. Kanukov. (1978). Naplavnye mosty, paromnye i ledianye perepravy. [***Floating bridges, ferry and ice crossings.***] Moscow: Transport, 1978. 384 pp. (In Russian with English table of contents enclosed.)*

Available from: See Introduction "Availability of documents" Items (a) and (d)

03 0160
To get around Arctic ice oil tankers might go under. *(1975). Canadian Petroleum 16(11): 32-34.*

Available from: See Introduction "Availability of documents" Item (b)

03 0161
Tompkins, T.G. (1979). **Industry crushes frozen obstacles.** *Offshore 39 (February 1979): 162-165.*

Available from: See Introduction "Availability of documents" Item (b)

03 0162
Toomey, P.R.M. (1973). **Icebreakers to control ice jams.** *Ottawa: National Research Council Canada. Associate Committee on Geotechnical Research. Technical memorandum, July 1973 No. 107, pp. 96-101.*

Available from: CISTI (Photocopying service)

03 0163
*Tretnikov, G. (1979). Provodka sudov vo l'dakh. [***Guiding ship caravans in ice.***] Rechnoi transport, 1979 No. 10: 42-43. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0164
Tronin, V.A. and L.V. Pushkarev. (1973). **River boat guiding in ice navigation.** *Hanover, N.H.: Cold Regions Research and Engineering Lab., Joint Publications Research Service, 1979. U.S. Army CRREL no. 695. 123 pp. (Translation).*
The book describes river icebreakers and transports adapted to navigate in ice, reviews questions of preparation for ice navigation, and considers ways to guide icebreakers in different ice conditions and during the performance of certain icebreaking jobs. (Author).

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (a)

03 0165
Tug-barge concept for hauling Arctic LNG. *(1977). Motor Ship 58 (August): 89-90.*

Available from: TC Library, Ottawa (Photocopying service)

03 0166

US icebreaker key to Superior trip's success. *Globe & Mail. Report on Business 24 February 1977: B4.*

Available from: See Introduction "Availability of documents" Item (c)

03 0167

United States. Coast Guard. (1971). **Test Project 721314, small scale explosive icebreaker, Muskedon, Michigan.** *Washington, D.C.: USCG. Draft environmental impact statement. 8 pp.*

The project is concerned with utilization of an explosive underwater ice breaking method in the Great Lakes and upper Mississippi River for the primary purpose of clearing sea lines in winter. Adverse impact effects anticipated include the possible effects of the explosions on marine life, noise levels on inhabitants, and gas discharges from the explosions.

Acknowledgement: NTIS
Available from: NTIS: cite PB-204 463-D
Price: $5.00 U.S.

03 0168

*Utkin, IU.M. and V.P. Stankevich. (1974). Ekspluatatsiia flota v ledovykh usloviiakh. [***Fleet operation in ice.***] Rybnoe khoziaistvo, Aug. 1974 No. 8: p. 25-27. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

03 0169

Voelker, R.P. (1977). **Operational capability of a polar research ship.** *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions, Memorial University of Newfoundland, St. John's, Nfld., September 26-30, 1977, pp. 464-474. St. John's, Nfld.: The University, Ocean Engineering Information Centre, 1978. 11 pp.*

Based on the projected developments in the Arctic regions and the corresponding lack of adequate oceanographic data in this area, the need for a research ship capable of operating in ice-covered waters has recently been established. The performance requirements for a research ship which would fulfill these needs includes the capability for breaking up to 0.46 m of level ice at a speed of 3 knots. As ice conditions in the polar regions vary as a function of time, it was decided to determine the operational limits of the ship for different geographic areas as a function of calendar month. This paper presents the results of that operational study for Arctic East, Arctic West, and Antarctica.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Items (a) and (b)

03 0170

Wade, R. (1975). **Air cushion technology in icebreaking.** *Hovering Craft and Hydrofoil 14(8): 20-23.*

Available from: See Introduction "Availability of documents" Item (b)

03 0171

Waggner, J.P. and K. Cappel. (1971). **Concept development program for icebreaking on the Upper Mississipi River.** *Philadelphia, Pa.: Franklin Institute Research Labs. Final Report. Report no. FIRL-C2717. 270 pp.*

A number of concepts were considered for cleaning a channel in the Upper Mississippi River. All of those concepts considered feasible utilized an upward breaking bow of shallow angle in combination with a conveyor or system for placing cleared ice well back from the channel. The use of impact or, mechanical cutters, jets, projectiles, heat and several other forms of ice management aids were reviewed. Two concepts, one using a fixed underwater scoring device and the other using a mobile impactor on top of the ice, were in the final selection process. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-723 995
Price: $15.00 U.S.

03 0172

Yakovelev, G.N. (n.d.). **Breaking ice with a jet of gas.** *Hanover, N.H.: Cold Regions Research and Engineering Lab. 19 pp.*

Thermodynamic methods are currently being applied successfully in industry for breaking rocks. These same methods have been examined for breaking ice. However, for large scale operations the use of a gas jet does not appear promising because of the large amount of energy required to melt ice. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-768 827/8

03 0173

*Zuev, V.A. (1969). K voprosu o razrushenii ledovogo polia pri rabote ledokola s raskachivaiushchei ustanovkoi. [***Cutting an ice field by an icebreaker equipped with a rolling installation.***] Gor'kii. Politekhnicheskii institut. Trudy, 1969-25(2): p. 66-72. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

03 0174

Zverev, B. (1968). **Operating loads of marine diesels navigating under ice conditions.** *Morskoy flot, March 1968-No. 3: 23 pp.*

Navigation of a ship in ice involves great loads on the hull, screws, shafts, and engines. Therefore the maneuvering conditions must be set with special care by the navigating staff and be applied to the engines with more know-how than is always the case in practice. Based on observations and measurements of temperatures and pressures, the article attempts to depict the loads on Zulzer 6RD-76 diesels when diesel-ships of the Krasnograd type travel in convoy in the ice of the Gulf of Finland. The authors found that the diesels were often overworked unnecessarily when following icebreakers. The operational charts supplied by the engine manufacturers must be followed, except under emergency conditions, which arise relatively rarely; in other words, the engines must not be allowed to labor. Abrupt and substantial changes in load, as the result of working out maneuvers and giving commands for them, affect the engines even more unfavorably, especially when proceeding through ice where resistance to motion of the vessel varies from normal to complete. Travel behind an icebreaker is not an emergency situation, and it is completely useless to overexert the engines under such conditions.

Acknowledgement: MRIS
Available from: CISTI (Photocopying service)

03 0630

Borodachev, V.E. (1974). **Ice distribution in Arctic Seas in Summer and its effect on the speed of ship movement.** *Leningrad: Articheskii I Antarkticheskii Nauchno-Issledovatel'skii Institut, vol. 316: 35-41.*

Acknowledgement: OEIC
Available from: OEIC: cite no. E01799

03 0631

Lawrence, R.G. (1979). **Canadian and international icebreaker needs and technology**. *Presentation to Marine Technology Society, Nfld. and Labrador Section, St. John's, Nfld. 36 pp.*

Acknowledgement: OEIC
Available from: Canadian Coast Guard OEIC: cite no. E04474

03 0632

Mellor, M. (1980). **Ship resistance in thick brash ice**. *Cold Regions Science and Technology 3(4): 305-321.*

Acknowledgement: OEIC
Available from: See Introduction "Availability of documents" item (b) see also OEIC: cite no. PE00654

03 0633

Naegle, J.N. (1980). **Ice resistance prediction and motion simulation for ships operating in the continuous mode of icebreaking**. *Ann Arbor: University of Michigan. (Ph.D. thesis).*

Acknowledgement: OEIC
Available from: OEIC

03 0634

Smiley, B.D. and A.R. Milne. (1979). **LNG transport in Parry Channel: possible environmental hazards**. *Sidney, B.C.: Institute of Ocean Sciences. 47 pp.*

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" item (a)

03 0635

Walter, W.G. and H.J. Reischauer. (1978). **The icebreaking capability of large ships**. *Paper presented at IAHR Symposium on Ice Problems, Lulea, Sweden, 7-8 August, 1978. Proceedings Part I, p. 479. 14. pp.*

It is shown that the existing theories for determination of ice resistance are of limited use when extrapolated to large non-icebreaker ship forms. A calculation method for the thrust required to generate vertical icebreaking forces at the bow and at lateral cusp points, derived from the forebody efficiency, is presented. The use of saline ice in model testing allows improved resistance predictions. The development of a special bow form, model tests with systematic variation of bow parameters, and the basic idea of a wedge bow are discussed. Comparisons are made with a conventional bow form.

Acknowledgement: BSRA
Available from: See Introduction "Availability of documents" items (a) and (b)

03 0701

Acres Consulting Services Ltd. (1978). **A study of parameters affecting the performance of submerged jet diffusers for ice management**.

Available from: Petro-Canada: cite no. 187

03 0702

Melville Shipping Ltd. (1978). **Resistance tests in ice for icebreaking LNG carrier**. *Report no. E91/78 & E92/78.*

Available from: Petro-Canada: cite no. 320

04 Ice Collision Damage, Shipwreck and Trapped Vessels

04 0175

Arctic ship damaged, Greenland is refuge. *Globe & Mail. Report on Business 21 October 1978: B13.*

Available from: See Introduction "Availability of documents" Item (c)

04 0176

Barr, William. (1978). **The drift and rescue of Solovei Budimirovich in the Kara Sea, January-June 1920**. *Canadian Slavonic Papers 20(4): 483-503.*

Describes the rescue of the Russian steamer Solovei Budimirovich which had jammed in the ice in the Kara Sea and had been drifting for 5 months with 85 people on board.

Acknowledgement: ASTIS
Available from: See Introduction "Availability of documents" Item (b)

04 0177

Barr, William. (1980). **The drift of Lenin's convoy in the Laptev Sea, 1937-1938**. *Arctic 33(1): 3-20.*

As a result of various miscalculations 25 ships underwent an enforced wintering at various points in the Soviet Artic in the winter of 1937-1938. Among the vessels involved was a convoy of six ships led by the icebreaker Lenin, which spent the winter drifting in the Laptev Sea. Several of the ships were severely damaged by ice pressure, and one ship was crushed and sank. Early in 1938 all superfluous personnel were flown south to Tiksi in an emergency airlift operation. The author presents the first detailed English-language account of this wintering. (Author).

Acknowledgement: ASTIS
Available from: See Introduction "Availability of documents" Item (b)

04 0178

*Beznos, L. (1969). Ledovye povrezhdeniia. [***Ice damages.***] Tekhnika i vooruzhenie Nov. 1969-No.11: p. 10-11. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (c)

04 0179

Blanchard, L. G. (1975). **Icebreakers beset, freed**. *Antarctic Journal of the United States 10(2): 59-61.*

Two U.S. Coast Guard icebreakers, (Burton Island) and (Glacier), and an Argentine icebreaker, ARA (General San Martin), became trapped in Antarctic ice at various times during Feb. and Mar. 1975. Although a special surface search and rescue unit was activated and ice reconnaissance flights were conducted to explore possible leads and changing ice conditions, each of the three vessels managed through its own efforts and with cooperative weather to break free of the ice.

Acknowledgement: CREEL
Available from: See Introduction "Availability of documents" Item (b)

04 0180

A list of iceberg casualties. *(n.d.) New York, N.Y.: International Ice Patrol. 8 pp.*

Available from: See Introduction "Availability of documents" Item (a)

04 0181

Manhattan damaged by ice. *(1970). Marine Pollution Bulletin 1(6): 91.*

Available from: See Introduction "Availability of documents" Item (b)

04 0182

*Neugodov, A. IU. (1977). Prichiny ledovykh povrezhdenii korpusov BMRT tipa "leskov". [***Ice damage to large "Leskov" type refrigerated fishing trawlers.***] Rybone khoziaistvo, June 1977-No.6: p. 41-44 (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

04 0183

St. Marys River clogged by ice; 23 ships idled. *Globe & Mail. Report on Business 2 May 1978: B2.*

Available from: See Introduction "Availability of documents" Item (c)

04 0184

*Savinykh, V.K., L.IA. Churakov and V.G. Morozov. (1976). K voprosu razrabotki metodov ustraneniia povrezhdenif vymorozochnykh kolodtsev. [***Preventing damage to the pits cut around ice bound objects.***] Novosibirsk. Institut inzhenerov vodnogo transporta. Trudy, 1976-Vol. 94: p. 49-52 (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

04 0185

Scott Polar Research Institute. (1979). **Shipping losses caused by ice, 1890-1977**. *Polar Record 19(121):343-362.*

Lloyd's Register of Shipping has published losses of all ocean-going merchant ships over 100 tonnes since 1890, including those resulting from encounters with ice. The list presented here gives details of where and how a loss due to ice occured and provides the nationality of the ship and, where known, its route and cargo. (Author).

Acknowledgement: ASTIS
Available from: Scott Polar Research Institute Lensfield Road Cambridge CBZ IER, England.

04 0186

*Semenov-Spasskii, L. (1975). Komandirskoe soveshchanie [***Meeting the crew***] Morskoi flot 1975-No. 4: p. 71-72.*

This is a popular account of the trapping of the research vessel Ob' in the fast ice and its rescue by the icebreaker [Navarin]. The problems of a ship and crew in this situation are presented in the form of a meeting of the crew at which the captain informs the men of their predicament and the measures being taken to relieve the ship.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Item (d)

04 0187

Svistelin, V. (1975). Primenenie vymorozok iznutri sudov. **[Repairs and ice-cup removal working from inside the ship.]** *Rechnoi transport, 1975-No.4: p.41, (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

04 0188

Twenty-four ships stuck in ice or aground in 8 weeks. *Globe & Mail. Report on Business 29 December 1976: B3.*

Available from: See Introduction "Availability of documents" Item (c)

04 0636

Canada. Coast Guard, Marine Casualty Investigation. **(1978). Formal investigation into the sinking of the M.V. William Carson, 3 June 77.** *St. John's, Nfld. 40 pp.*

This report contains the formal investigation by the court, St. John's, province of Newfoundland into the sinking of the M.V. William Carson, 3 June, 1977.

Acknowledgement: Canadian Coast Guard
Available from: Canadian Coast Guard, Ottawa. This is an unpublished report.

04 0637

Canada. Coast Guard. Marine Casualty Investigations. (1978). **Summary report of investigation into the circumstances surrounding the ice damage sustained by the Canadian M.V. "Arctic" on or before October 17, 1978.** *Ottawa: Transport Canada. 8 p. (TP 1624).*

The M.V. "Arctic" was commissioned in June 1978 and loaded her first cargo of grain in Toledo, Ohio. Following her initial voyage from Canada to Antwerp, the "Arctic" made two trips to Nanisivik, Strathcona Sound, North West Territories, carrying lead and zinc concentrates from that port to Antwerp, Belgium. At the time of the subject casualty she was on her third voyage from Nanisivik and the last, from the port, of the season.

Acknowledgement: Canadian Coast Guard
Available from: Canadian Coast Guard, Ottawa. The contents of this report are confined to cause-related circumstances and are released for accident prevention purposes only.

04 0638

Canada. Coast Guard. Marine Casualty Investigations. (1979). **Summary report of investigation into the circumstances attending the bow damage sustained by the Canadian icebreaker "John A. MacDonald", discovered on November 25, 1978.** *Ottawa: Transport Canada. 10 pp. (TP 1624)*

Dome Petroleum and their subsidiary company, Canadian Marine Drilling Ltd. have been operating drill ships in the Beaufort Sea area, supported by a fleet of supply boat/tugs and a larger supply ship. The season is very short due to sea ice hampering the drilling operations so Dome negotiated a contract with Transport Canada to hire an icebreaker to assist their operations during the spring break-up and fall seasons. The "John A MacDonald" was the vessel chosen and she was given orders to proceed to Resolute where surveys would be conducted prior to the vessel being chartered 'on hire' by Dome Petroleum. The "John A MacDoanld" arrived off Resolute on August 29, 1978.

After leaving Resolute on September 2, at 1815 hours, the vessel proceeded westward through Prince of Wales Strait and after arriving off Tuktoyaktuk performed various functions, described later in this summary. Having completed some ice testing experiments, she returned to Summers Harbour to winterize on November 19, 1978. On November 25, a diving team was mobilized to investigate a leak into the starboard heeling tank and the bow damage was discovered on November 27 in way of the forward deep tank. This tank had previously contained some 230 tons of diesel oil but there was no evidence of pollution in the area at the time.

Acknowledgement: Canadian Coast Guard
Available from: Canadian Coast Guard, Ottawa. The contents of this report are confined to cause-related circumstances and are released for accident prevention purposes only.

04 0639

Canada. Coast Guard. Marine Casualty Investigations. (1979). **Summary report of investigation into circumstances in which Liberian tanker "Marilia" suffered ice damage in Cabot Strait on March 1, 1979.** *Ottawa: Transport Canada. 4 p. (TP 1624)*

The tanker "Marilia", built in Sweden in 1967, sailed under the Norwegian flag as the 'Beauval' for eleven years before being transferred to Liberian Registry under her present name.

She is constructed with bridge and engines aft and has four cargo tanks consisting of 5 wing tanks on each side and four centre tanks. Additionally, between her fore-peak tank and her forward cargo tanks is a deep tank which is normally used for ballast as and when required. She has a bulbous bow and is not strengthened for navigation in ice. This report gives the details of the investigation into the circumstances in which the Liberian tanker Marilia suffered ice damage in Cabot Strait on March 1, 1979.

Acknowledgement: Canadian Coast Guard
Available from: Canadian Coast Guard, Ottawa. The contents of this report are confined to cause-related circumstances and are released for accident prevention purposes only.

04 0640

Canada. Transport Canada. (N.D.) **Vessel ice casualties in Canadian waters excluding strikings and excluding fishing vessels 1966 to 1980 inclusive.** *23 pp.*

This report gives the known ice casualties to vessels in Canadian waters excluding strikings and fishing vessels 1966 to 1980 inclusive.

Acknowledgement: Canadian Coast Guard
Available from: Transport Canada, Ottawa. This is an unpublished report

04 0641

Catinus, W.A.W. (1975). **Ice damage to vessel M.V. "Andrew C. Crosbie"** *July 10, 1974.*

This report by superintendant, Marine Investigation & Wreck is in reply to a letter from Mr. Michael Davis advocate, regarding the ice damage to vessel M.V. Andrew C. Crosbie. Brief details of the damage is given from when the ship sailed July 5, 1974 until it arrived in Montreal July 13, 1974. A summary report was not issued.

Acknowledgement: Canadian Coast Guard
Available from: Canadian Coast Guard, Marine Casualty Investigations, Ottawa. This is an unpublished report.

04 0642

United States. Coast Guard. (1973). **Iceberg casualties.**

Over 61 years have elapsed since the tragic sinking of the "RMS Titanic", the international clamor from which brought about the International Ice Patrol. In conducting an extensive literature seach for other iceberg related casualties, letters, newspaper accounts and the files of Lloyds have been reviewed. These results are tabulated on the following pages to present the reader an awesome display of the death and

destruction brought upon mankind of one of natures formidable creations... the iceberg. Neither the 19 incidents in the hundred years before nor the 37 incidents in the 61 years after the "Titanic" are meant to be all inclusive. There have been undoubtedly many instances of 'brushing' against icebergs with damage so minor as to not require reporting as well as occasions of iceberg damage that were never reported. There are also ships which have left port on trans-Atlantic voyages and been claimed by the ocean without report. Some of these are undoubtedly attributable to icebergs. Readers with information on iceberg casualties not included on this list or amplifying data on the categories labeled as unknown are invited to send them to Commander, International Ice Patrol, Building 110, U.S. Coast Guard Support Center, Governors Islands, NY 10004. Because of the above, a reasonable statistical analysis of the data is not possible. It is interesting to note, however, that in over half the reported incidents the ships either sank or were abandoned. What is important, is the fact that not one reported iceberg casualty has occurred in the vicinity of the Grand Banks of Newfoundland outside the eastern, south-eastern and southern limits of all known ice as published by the International Ice Patrol.

Acknowledgement: United States Coast Guard

Available from: Commander, International Ice Patrol TDC. This is an unpublished report

05 Ice Navigation — General

05 0189

Aleksandrov, A. et al. (1975). **Inland navigation and maintenance of hydraulic structures at negative air temperature in ice-bound conditions**. *In Proceedings of the International Symposium on Ice Problems, 3rd, Hanover, New Hampshire, August 18-21, 1975, pp. 69-79. [S.l.]: International Association of Hydraulic Research, 1975*

Available from: See Introduction "Availability of documents" Items (a) and (b)

05 0190

Atkinson, H. T. (1976). **Scientists study polar gyrations: may predict safe paths through ice**. *Ocean industry 11(9): 225-226, 228, 230, 233, 234.*

Available from: See Introduction "Availability of documents" Item (b)

05 0191

*Babain, V.A. (1969). analiticheskoe reshenie zadachi vybora naivygodneishego puti vo l'dakh. [***Analytical solution of optimal route selection in ice navigation***.] Leningrad. Nauchno-issledovatel'skii institut morskogo flota. Trudy, 1969-Vol. 115: p. 59-64. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0192

*Bolin, R. (1974). Isproblem i farleder och hamnbassanger. [***Ice problems in shipping lanes and harbor basins***.] Styrelsen for Vintersjofartsforskning. Forskningsrapport. 1974-No. 7: p. 159-163. (In Swedish.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0193

*Bulavkin, V.M. (1973). Ob effektivnosti ledovoi aviatsionnoi razvedki v arkticheskom moreplavanni. [***Effectiveness of aerial ice surveys in Arctic navigation***.] Leningrad. Arkticheskii i antarkticheskii nauchno-issledovatel'skii institut. Trudy. 1973-Vol. 307: 194-198.*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0194

*Buzuev, A.IA. and P.A. Gordienko. (1976). Kolichestvennaia ostenka trudnosti plavaniia sudov vo l'dakh. [***Quantitative evaluation of ice navigation difficulties***.] Meteorologiia i gidrologiia, Sep. 1976-No. 9: p. 60-66. (In Russian with English summary.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0195

Canada. Coast Guard. (1977). **Ice navigation in Canada waters**. *Ottawa: Information Canada. 29 pp.*

Available from: See Introduction "Availability of documents" Item (a)

05 0196

Canada. Hydrographic Service. (1978-). **Sailing directions — Arctic Canada**. *3rd ed. Ottawa: Dept. of Fisheries and the Environment.*

...The Sailing Directions... contains the following information on the Canadian Arctic: physiography, population, history of exploration, climate, tides and currents, ice glossary, ice conditions, navigation in Arctic waters, ship handling in ice, and other information of interest to a mariner planning to navigate in the Canadian Arctic. ... (Author).

Acknowledgement: ASTIS
Available from: See Introduction "Availability of documents" Item (a)

05 0197

Canada. Marine Transportation Administration. (1971). **Evolution of Canadian development in the field of winter navigation on the St. Lawrence River and Great Lakes**. *Ottawa, Ontario: Ministry of Transport. 21 leaves.*

Available from: TDC Library, Montreal (Interlibrary loan)

05 0198

Canada. Marine Transportation Administration. (1972). **Review of recent Canadian activities for the extension of the navigation season: Gulf of St. Lawrence and Great Lakes**. *Ottawa, Ontario: Canadian Marine Transportation Administration. approx. 20 leaves.*

Available from: TDC Library, Montreal (Interlibrary loan)

05 0199

Carter, L.J. (1975). **Icebergs and oil tankers: USCG glaciologists are concerned**. *Science 190(4215): 641-643.*

Available from: See Introduction "Availability of documents" Item (b)

05 0200

*Chuchukin, A. (1979). Bezopasnost' rabot na ledovom pripae. [***Safe working conditions on fast ice***.] Morskoi flot, 1979-No. 4: 26-27. (In Russian.)*

Precautions to be taken before and during unloading of cargo on an ice shelf are discussed. Two broad concerns face planners: avoidance of breakup of the ice itself, and preventing the ship from being entrapped.

Acknowledgement: CREEL
Available from: See Introduction "Availability of documents" Item (d)

05 0201

Clapper, R.T.J. et al. (1975). **Ice growth studies in Duluth-Superior Harbor 1974-75**. *Duluth, Minnesota: University of Minnesota. Final report no. NOAA-77082522. 70 pp.*

This study concerns the investigation of the ice growth and heat budget in the Duluth-Superior Harbor. The Harbor, located at the extreme

western end of Lake Superior, is one of the major shipping ports on the Great Lakes. It is ice bound from mid December to mid April, causing cessation of interlake shipping in the winter months. The lake ice does not pose a severe navigational problem until ice packing occurs due to prolonged easterly winds in the early spring. Initial investigations on the feasibility of winter shipping in Duluth resulted in installation of an experimental bubbler system which was devised to keep the channels open in the early winter. However, the physical principles governing the ice growth in the Harbor are complex and not well understood. Problems arising in ice growth forecasting, design and construction of ice retarding methods, and evaluation of the environmental implications of winter shipping require a detailed investigation on the physical processes and the heat budget for the entire Harbor.

Acknowledgement: NTIS
Available from: NTIS: cite PB-272170/2ST

05 0202

Cowley, J.E. and A.B. Cammaert. (1977). **Navigation delays due to ice conditions: analysis and case studies**. *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic conditions. Memorial University of Newfoundland, St. John's, Nfld., September 26-30, 1977. St. John's, Nfld.: The University, Ocean Engineering Information Centre, 1978. 11 pp.*

In planning marine facilities in Canada, a major factor of uncertainty has been the time delay to shipping due to ice conditions. This paper outlines a general approach to the problem and discusses the application of the approach to several recent projects in Eastern Canada.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Items (a) and (b)

05 0203

Culshaw, S.T. and B.R. LeDrew. (1977). **Labrador Sea ship-in-the-ice: a pilot study**. *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions, St. John's, Newfoundland, September 26-30, 1977, vol. 2, pp. 1122-1131. St. John's, Nfld.: Memorial University of Newfoundland, Ocean Engineering Information Centre, 1978.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

05 0204

Dickins, D.F. and R.O. Ramseier. (1974). **Studies on the extension of winter navigation in the St. Lawrence River**. *In International Symposium on River and Ice, Budapest, Jan. 14-18, 1974. Proceedings. Contribution to subject B: Interrelations among river training, river canalization, low head water power development and navigation with special regard to ice control. Preprints. p.99-107. Budapest, 1974.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

05 0205

Dmitriev, V.M. et al. (1975). Ispytaniia prochnosti ledokola v Arktike. **Use of ice forecasting in the Arctic**. *Sudostroenie Mar. 1975-No. 3: p. 11-13. (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0206

Drillship eases dangers from icebergs. *(1975). Oil and Gas Journal 73 (19): 38-40.*

Available from: See Introduction "Availability of documents" Item (b)

05 0207

*Frolov, R.D. (1970). Navigastionnoe obespechenie flota pri rabote v ledovykh usloviiakh. [***Provisions for ice navigation***.] Opyt provodki rechnykh sudov v ledovykh usloviiakh (Experience in ice navigation of river vessels): p. 30-36. Moskow. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (a) and (d)

05 0208

Gibbs, G. (1975). **Omega in the Arctic and its rendez vous capability for logistic supply**. *Canadian Aeronautics and Space Journal 21(6): 210-217.*

Available from: See Introduction "Availability of documents" Item (b)

05 0209

Hackman, D.J. and R.L. Brunel. (1973). **Design of a combination bubbler-guidance system to be installed in Whitefish Bay, Michigan**. *Columbus, Ohio: Battelle Columbus Labs. Final report 13 Nov.'72-15 Jan.'73. 116 pp.*

The U.S. Coast Guard and U.S. Army Corps of Engineers selected the navigation channel at the Whitefish Bay end of the St. Marys River for the installation of a combined bubbler-wire guidance system. This system is to extend the navigation season on the Great Lakes by retarding the formation of ice and by providing a navigation aid. Support equipment will be installed on Point Iroquois, Michigan. Laboratory tests and engineering analysis showed that the bubbler line should be 3 miles long and composed of PVC pipe with 1/32-inch orifices every 15 feet. The wire-guidance system will be 7 miles long and use NO. 4 AWG insulated cable with a 1-kw, 400-hertz signal generator. The report contains engineering descriptions, design details, and cost estimates necessary for installing the bubbler-wire guidance system. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD 773.345/4
Price: $9.00 U.S.

05 0210

Ice, bad weather conditions fail to halt shipping operations on Upper Great Lakes. *Globe & Mail. Report on Business 16 February 1978: B1.*

Available from: See Introduction "Availability of documents" Item (c)

05 0211

Jewett, E. (1978). **Towing icebergs to protect drilling rigs in the Arctic**. *Ocean Industry 13(4): 44-48.*

Since the practice was begun in 1971, 14 icebergs tows have been performed off the east coast of Canada and W of Greenland to protect drilling operations. Pushing, floating a towline, and prop-wash methods of moving bergs are discussed. A new as yet untried concept involves use of a 7-ft diameter suction cup called DAK. Powered by water jets run through ejector nozzles, it has developed 1 atm of vacuum during trials against steel and concrete surfaces, amounting to a suction of 34 tons, enough to handle smaller bergs. An additional atm of pressure can be gained for each 10 m the head is immersed. Coordination of berg towing is done by ice observers who maintain a 24-hr watch from the rig and work directly with the supply boats and the drilling superintendent. Beyond the immediate ice protection services, ice observing contributes to data which will provide design criteria should the area go into production. (FT)

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

05 0212

Johannson, B.M. (1974). **Influence of winter on the navigation in the northern part of the Gulf of Bothnia.** *Styrelsen for vintersjofartsforskning. Forskningsrapport, 1974-No. 7: p. 31-69. (In Swedish.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0213

Kamaev, V. (1978). Provodka sudov v ledovykh usloviiakh. **[Guiding ships through ice.]** *Rechnoi transport, 1978-No. 12: 43-44. (In Russian.)*

Acknowledgement: CISTI (Protocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0214

Keating, B. (1970). **Northwest Passage, from the Mathew to the Manhattan, 1497 to 1969.** *Chicago: Rand McNally. 152pp.*

Available from: See Introduction "Availability of documents" Item (a)

05 0215

Khimich, B.P. (1977). Raschet optimal'nogo kolichestva sudov na sudokhodnoi linii s uchetom gidrometeorologicheskikh uslovii. **[Calculating the optimal number of ships for an ice navigation route allowing for hydrometeorological conditions.]** *1977-Vol. 50: p. 94-98. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0216

Kniskern, F.E. (1967). **Routing ships through ice infested areas.** *Navigation 14(1): 65-71.*

Available from: See Introduction "Availability of documents" Item (b)

05 0217

Kukharskii, A. (1968). Vozmozhnoe budushchee pri plavanii vo l'dakh. **[The future of ice navigation.]** *Morskoi flot May 1968-No. 5: 34*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0218

Legerer, F.J. (1975). **Discussion contribution regarding improvement potential of ice navigation.** *Nato conference series: II, Systems science, Conference on Arctic systems, St. John's, Newfoundland, August 1975. Proceedings, 1977-Vol. 2, p. 503-512.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

05 0219

Machin, P. (1974). **Integrated bridge systems.** *Shipbuilding and Shipping Record 123 (18-25 January): 33 +*

Available from: TC Library Ottawa (Photocopying service)

05 0220

Mainagashev, B. and I. Stoianov. (1974). Skorost' i bezopasnost' plavaniia vo l'dakh. **[Speed and safety of ice navigation.]** *Morskoi flot, 1974-No. 8: p. 50-52. (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0221

Makinen, P. (1972). **Winter navigation in the Bothnian Bay and the iceworthiness of merchant vessels.** *Ann Arbor, Mich.: University of Michigan, Dept. of Naval Architecture and Marine Engineering. Contract no. 1-35487. 31 pp.*

The first section covers winter climate and organization of sea transportation in Bothnia Bay. The winter freeze up begins about mid-December and lasts until mid-May with ice thickness ranging between 50 and 75 cm with a comparatively low salt content of 3 or 4 parts per thousand. The second part deals with the structural strenghtening of vessels including the economics. The third section reviews ice damage, insurance, winter navigation fees, freight, icebreakers and a brief comparison with the railroads as an alternative solution. The author concludes that the winter transportation system of Bothnia Bay can certainly be managed better but it can scarcely be improved by lenghtening the navigation season.

Acknowledgement: MRIS
Available from: Michigan University, Ann Arbor Department of Naval Architecture and Marine Engineering, Ann Arbor, Michigan 48104

05 0222

Martishin, V. (1977). Vangurei: "Ledovyi prichal-77". **[Vangurey camp: "Ice Berth-77".]** *Morskoi flot, 1977-No. 9: p. 22-24. (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0223

Maybourn, R. (1970). **Satellite navigation of N-W passage.** *Tanker and Bulk Carrier 17(May): 27.*

Available from: See Introduction "Availability of documents" Item (b)

05 0224

Mesto raboty-Arktika. **[Place of work-the Arctic.]** *Morskoi flot, 1974-No. 5: p. 37-41. (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0225

Mookhoek, A.D. and W.J. Bielstein. (1971). **Problems associated with the design of an Arctic marine transport system.** *In Offshore Technology Conference, 3rd, April 19-21, 1971, Houston, Texas, Preprints, v. II, pp. 123-146.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

05 0226

More icebreakers to meet demand for longer Arctic navigation season. *(1973). Motor Ship 54 (October): 324-328.*

Available from: TC Library Ottawa (Photocopying service)

05 0227

Mustafin, N.V. (1967). Okoanologiia na sluzhbe moreplavaniia v Arktike. **[Oceanology at the service of seafaring in the Arctic.]** *Problemy Arktiki i Antarktiki, sbornik statei, 1967-Vol. 27: p. 16-34. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0228

*Nitzki, L. (1977). Arktische Transportsysteme. [***Arctic transportation systems.***] Schiffbautechnische Gesellschaft. Jahrbuch, 1976 (publ. 1977)-Vol. 70: 1-6. (In German.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0229

*Pavskii, E.I. et al. (1972). Ekonomicheskaia effektivnost' prognozov prirodnykh uslovii sudokhodstva v Arktike. [***Economic effectiveness of forecasting navigation conditions in the Arctic.***] Problemy Arktiki i Antarktiki Sbornik statei, 1972-Vol. 40: p. 105-110. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0230

St. Marys ice delays traffic. *Globe & Mail, Report on Business 11 January 1979: 816.*

Available from: See Introduction "Availability of documents" Item (c)

05 0231

*Severnoe parokhodstvo segonia i zavtra. [***Northern steam navigation today and tomorrow.***] Morskoi flot July 1978-No. 7: 16-18. (In Russian).*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0232

*Shemarin, G. (1977). Uchenye-moriakam Arkticheskogo basseina. [***Scientists helping sailors of the Arctic Basin.***] Morskoi flot 1977-No. 1: p. 52-53. (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0233

Smirnov, V.I. (1970). **Methods for short range forecasting of navigability in close sea ice.** *Problems of the Arctic and Antarctic, issues 29-32: 65-70.*

Acknowledgement: CISTI (Photocopying service)

05 0234

*Soboleva, D.R. and A.O. Shpaikher. (1970). O vozmozhnosti zimnego plavaniia severo-zapadnym prokhodom. [***Possibility of winter navigation through the northwest passage.***] Problemy Arktiki i Antarktiki Sbornik statei 1970-Vol. 35: p.67-75. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0235

Tankers take 4 days for 601 miles through heavy ice. *Globe & Mail Report on Business 17 February 1977: B11.*

Available from: See Introduction "Availability of documents" Item (c)

05 0236

Thunder Bay battles 49-inch-thick ice and contract dispute to open '79 season. *Globe & Mail. Report on Business 12 April 1979: B10.*

Available from: See Introduction "Availability of documents" Item (c)

05 0237

Turner, M.A. (1977). **Arctic traffic management, navigation and communication system.** *NATO conference series: 11, Systems science, Conference on Arctic systems, St. John's, Newfoundland, August 1975. Proceedings, 1977-Vol. 2, p. 19-48.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

05 0238

United States. Army. Corps of Engineers, Detroit District. (1973). **Navigation season extension demonstration program.** *Final Environmental Impact Statement. 285pp.*

The FY 1974 Navigation Season Extension Demonstration Program is part of a three-year program to demonstrate the practicability of extending the commercial navigation season on the Great Lakes and St. Lawrence Seaway. Methods investigated for the purpose of extending the navigation season include bubbler systems, ice breaking activities, ice retarding heat additives in the form of power plant heat rejections and ice stabilization and retention structures. Also investigated are modifications to vessels to increase ice navigation capabilities and various types of navigational aids to permit safer navigation during winter weather conditions. Environmental impacts are discussed.

Acknowledgement: NTIS
Available from: NTIS: cite EIS-MI-73-1933-F
Price: $20.50 U.S.

05 0239

*Voevodin, V.A. (1979). Osobennosti ledovoi aviarazvedki i ee effektivnost' pri provodke sudov v usloviiakh szhatiia 1'dov. [***Effectiveness of aerial ice surveys in navigation under ice cover contraction conditions.***] Leningrad. Arkticheskii i antarkticheskii nauchno-issledovatel'skii institut. Trudy 1979-Vol. 363: p. 134-139. (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

05 0240

WMO Technical Conference on the Applications of Marine Meteorology to the High Seas and Coastal Zone Development, Geneva, Switzerland, November 22-26, 1976. *Papers. In World Meteorological Organization. Report no. 454. Geneva, 1976. 554pp.*

Topics covered include weather services, safety and meteorology, ship-borne weather stations of the Federal Republic of Germany, the role of the ship-borne observer, the role of the ship's officer, measurement of sea state, marine hydrometeorological services, meteorological graphics, climatology of wave heights, presentation of service information, the ship routing office of the Royal Netherland Meteorological Institute, ocean routes for ships, ship routing, the use of meteorology in combatting oil pollution on the Indian Coast, meteorological observation in fishery research and management, hydrometeorological services for fishing, heat transfer studies over the north Indian Ocean, oceanographic services, sea surface temperature information, NOAA operational products, SEASAT-A and NIMBUS-G, a meteorological satellite receiving station, marine fog, data management, marine climatology, wave forecasting, winter navigation and ice breaking service in the Baltic Sea, a modern ice information service, and iceberg movement in the North Atlantic Ocean. Other topics covered include services for coastal zone activities, meteorological support, the implications of a coastal upwelling forecast, environmental data in offshore engineering, Noewegian meteorological support, specialized support to offshore drilling, dependence of tsunamis on earthquake mechanisms, a climatic appraisal of the development potential of the coastal zones of India, a

semi-automated method for wave prediction, Danish storm surge warning and the North Sea storm surges of Jan. 1976, Canadian data buoy developments, anchored buoys network near French-Atlantic coast, the U.S. buoy development program, drift computation for search and rescue, and environmental data in El Nino investigations. Topics concerning marine meteorological services at ports are included (FP, FT)

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (a)

05 0241

*Wahlstrom, I. (1974). Ett bulkrederis synpunkter pa vintersjofart i Bottenviken. [***Bulk cargo company's viewpoints on winter navigation in the Gulf of Bothnia***.] Styrelsen for Vintersjofartsforsknining. Forskningsrapport. 1974-No.7: p.25-29. (In Swedish.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

05 0242

White, W.H. (1978). **New era-reality or illusion: summary of "Meeting the Arctic challenge"**. *Marine Week 5 (3 March): 10-11.*

Available from: See Introduction "Availability of documents" Item (b)

05 0643

Anderson, K.G. (1979). **Lake Melville/Offshore Labrador navigation 1979-80 update. Probe no. 2 by CCGS "Franklin"**. *Report prepared for government of Newfoundland and Labrador Dept. of Industrial Development by Fenco Ltd. Calgary, Alta. 2 p.*

Acknowledgement: OEIC
Available from: OEIC: cite B00946-02 See also Introduction "Availability of documents" item (a)

05 0644

Benedict, C.P. (1976). **Icebergs and Canadian East Coast exploration**. *Contributed by the Petroleum Division of the American Society of Mechanical Engineers for presentation at the Joint Petroleum Mechanical Engineering and Pressure Vessels and Piping Conference, Mexico City, Mex., September 19-24, 1976. New York: United Engineering Center.*

This paper describes icebergs in relation to Canadian East Coast drilling activity Measurement systems are described, together with base line data on iceberg drafts recovered during the 1974 drilling season and reported here for the first time.

Acknowledgement: ASME
Available from: ASME See also Introduction "Availability of documents" item (a)

05 0645

Benedict, C.P. (197). **Underwater profiling of icebergs**. *Iceland: University of Iceland, Dept. of Engineering and Science.*

This paper deals with the measurement of the profiles of icebergs; specifically with the underwater cross sections of floating bergs off the east coast of Canada.

The underwater profile system incorporates a narrow fan shaped beam of acoustical energy to obtain an accurate approximation to the overall shape.

In this operational technique a transducer is lowered and raised while being rotated in a horizontal plane. The iceberg is outlined in this way from a succession of stations on a circumference about the berg.

The particular parameters recorded are decided on the basis of information necessary to minimize the hazards in towing icebergs which would otherwise threaten collision with fixed platforms or submerged pipe conduit.

Available from: See Introduction "Availability of documents" item (a)

05 0646

Benedict, C. Peter and J.C.E. Hall. (1979). **A study of iceberg detection for marine navigation**. *St. John's, Nfld.: Ice Engineering. 200 leaves. (Canada. Ministry of Transport. TP 2409)*

Available from: TDC Library, Montreal

05 0647

Benedict, C. Peter and J.C.E. Hall. (1980). **A study of iceberg detection for marine navigation: summary report**. *Montreal: Transport Canada Development. 13 leaves. (Canada. Ministry of Transport. TP 2414)*

Available from: TDC Library, Montreal

05 0648

Bradford, D. (1973). **Environmental conditions affecting navigation in the Newfoundland — Labrador Coastal Area**. *Newfoundland Coastal Transportation Study, Volume 5. Ottawa: Department of Transport. 76 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. B00301

05 0649

Clarke, J.T. (1980). **The future Arctic Marine transportation system. Decade of the Oceans**. *Proceedings of the Annual Conference of the Marine Technology Society, 16th, Washington, D.C., 1980. pp. 210-215.*

Acknowledgement: OEIC
Available from: OEIC

05 0650

Dosman, E.J. (1978). **Arctic Seas: Marine transport**. *Northern Transitions, vol. 2: 354-367. National Workshop on People Resources of the Environment North of 60°. Edmonton, 1978. Ottawa: Canadian Arctic Resources Committee.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00164-02-AA See also Introduction "Availability of documents" item (a)

05 0651

Dunbar, M. (1980). **Robeson Channel, ice drift and oceanographic measurments, 1970-1975**. *Ottawa: Defence Research Establishment. 1 vol.*

Acknowledgement: OEIC
Available from: OEIC See also Introduction "Availability of documents" item (a)

05 0652

Fothergill, N. (1971). **Radar detection of ships in ice strewn waters**. *Canadian Seminar on Icebergs, 1971, pp. 100-108.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00109-AK

05 0653

Godin, G. (1980). **Modification of the tide in the Canadian Arctic by an ice cover**. *Fisheries and Oceans Canada, Marine Sciences and Information Directorate, Manuscript Report Series no. 56. 29 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. E05981 See also Introduction "Availability of documents" item (a)

05 0654

Gulf Canada Resources Inc. (n.d.) **Arctic Islands ice movement — 1971 to 1979**. *File no. G-2076-31. 52 pp.*

Ice movement data has been collected at various locations in the Sverdrup Basin in conjunction with on ice drilling operations and from "remote" stations specifically designed to measure ice motion. The methods used to collect this information have included direct measurment from shore, acoustic measurements between the ocean floor to the under ice surface and Doppler Satellite positioning system measurements. Some of the resultant ice movement data has been received in the form of graphs with scales varying from one in fifty to one in one hundred and twenty while other data has been received in the form of tabular computer printouts. The information given in this report has been extracted from the various partner, APOA and AIEG study reports that have been received since ice movement measurements were initiated in 1970. Here, the location, times and results of the ice movement measurements are summarized in both tabular and graphical format. Overlays showing the five percent movement radii for various water depths are also provided. These can be used to quickly determine the available drilling period at given locations where ice platform wells are being considered.

Acknowledgement: Gulf Canada Resources Inc.
Available from: Gulf Canada Resources Inc. This is an unpublished report

05 0655

Gulf Canada Resources Inc. (197). **The Point Barrow access route to the Beaufort sea**. *File no. G-3150-14. 14 pp.*

The purpose of this report is to summarize the results of an analysis concerning navigation into the Beaufort Sea from the West, via Point Barrow. This information is of obvious importance when considering the initiation of CANMAR's operation in 1976. An analysis of the Point Barrow access route to the Beaufort Sea is completed and presented in this report. Although subject to a number of assumptions, the results indicate that on the average, a vessel capable of navigation in an ice cover of less than 10/10 concentration could begin the passage on July 19th with arrival on location in the Canadian Beaufort Sea by July 20. However, a standard deviation of 30 days around this entrance date reflects the annual variability in ice conditions and points to the uncertainties associated with an average figure. From a probabilistic standpoint, the results indicate that in three out of four years, CANMAR's vessels could begin the passage on July 19.

Acknowledgement: Gulf Canada Resources Inc.
Available from: Gulf Canada Resources Inc. This is an unpublished report

05 0656

Gulf Canada Resources Inc. (1974). **Eastern access routes to the Beaufort Sea**. *File no. G-3150-11. 71 pp.*

The purpose of this report is to summarize the results of an analysis concerning navigation to and from the Beaufort Sea via the Arctic Islands archipelago. Although the analysis was completed for the Beaufort Sea Exploratory Drilling System Review in July of 1974, it has now been printed for distribution and future reference. An analysis of the eastern routes to the Beaufort Sea has been completed and is presented in this report. Although subject to a number of assumptions, the results indicate that on an annual basis, navigation through the Arctic Islands region is unreliable. In addition, it is shown that use of the "navigable time window" through the archipelago does not permit a reasonable drilling period within the Beaufort Sea. In a relative sense, the optium access route appears to be via Coronation Gulf, Prince Regent Inlet and Lancaster Sound. Assuming successful navigation in an ice cover of less than 10/10ths concentration, the results indicate that at the 75% probability level, this route would allow 35 days of Beaufort Sea drilling whereas at the 50% probability level, 56 drilling days would be available. With a 7/10th ice cover limitation, these time periods reduce to 0 and 17 days respectively.

Acknowledgement: Gulf Canada Resources Inc.
Available from: Guld Canada Resources Inc. This is an unpublished report

05 0657

Gustajtis, A.K. (1979). **Iceberg population distribution study within the Labrador Sea**. *C-CORE Publication 79-8. 41 pp. Data Report.*

Acknowledgement: OEIC
Availalbe from: OEIC: cite H00216 See also C-CORE

05 0658

INTERA. (1978). **Ice pressure ridge statistical summaries, Keene Bank region**. *1 vol. 52 pp.*

This report was prepared by Intera, acting as environmental consultant to fisheries and oceans Canada, regarding the ice pressure ridges statistical summaries — Reene Bank Region.

Acknowledgement: OEIC
Available from: OEIC See also Introduction "Availability of documents" item (a)

05 0659

Jacobs, J.D., R.G. Barry and R.S. Bradley. (1974). **Studies of climate and ice conditions in Eastern Baffin Island, 1971-73**. *Institute of Arctic and Alpine Research. Occasional paper no. 9. Boulder: University of Colorado, Institute of Arctic and Alpine Research. 77 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. B00313

05 0660

Johanssen, L.R. (1979). **Ice problems for ships and platforms**. *Veritas 25(97): 3. 4 pp.*

Ships navigating in ice are exposed to damage and risk being icebound for long periods. Forcing a ship through thick ice may indent the shell plating, frames and stringers. Propeller and rudder are expecially vulnerable. The Veritas and Finnish Rules for construction of steel ship, navigation in ice, and strengthening requirements are discussed. The estimated ice thickness that a ship in motion will be able to force without assistance is reviewed.

Drilling platforms can never be made strong enough to withstand an iceberg of significant size. Fixed production platforms cannot be used where icebergs cannot be towed away or blown up. Subsea completions, where the wellhead and necessary equipment is placed on the sea bed, may be installed. Production may then be transmitted by pipeline along or under the sea bed. Intensive research is being focused on such production systems.

Acknowledgement:
Available from: See Introduction "Availability of documents" item (b)

05 0661

Keelty, J.M. and S.Y.K. Tam. (1980). **Sea-ice thickness radar measurements in the Beaufort Sea**. *Report no. MPBT-157R-1. Final report. 32 pp.*

An investigation into the use of experimental VHF pulse amplitude modulated radars for the measurment of sea-ice thickness is reported. The measurements were carried out from a helicopter in the Beaufort Sea over brackish, first-year and multiyear ice. The experiments show that synthetic pulse radar can successfully measure ice thickness of

2 meters to 7 meter range. The nature of additional work required in the antenna and electronics areas to produce an operational prototype is identified.

Acknowledgement: MPB Technologies Inc.
Available from: TDC. This is an unpublished report

05 0662

La-Borde Simat. (1971). **Arctic-Island supply study**. *Canada, Dept. of Indian and Northern Affairs, Oil and Gas, Geology Section, Report 811-18-10-1: 201 pp.*

An examination of the various methods for transporting equipment and supplies into oil, gas and mineral exploration sites in the Arctic-Islands. Contract report prepared by La-Borde Simat, Calgary, Alta.

Acknowledgement: OEIC
Available from: OEIC: cite no. MFJ0001 See also Introduction "Availability of documents" item (a)

05 0663

LeDrew, B. and K.A. Gustajtis. (1979). **Oil spill scenario for the Labrador Sea**. *Environment Canada, EPS-1-EC-79-4.*

Chapter 5: Labrador Sea synoptic ice description. Chapter 6: Ice feature characterization Labrador offshore. Chapter 7: Iceberg hazard.

Acknowledgement: OEIC
Available from: OEIC See also Introduction "Availability of documents" item (a)

05 0664

Lindsay, D.G. (1976). **Sea ice atlas of Arctic Canada**. *Ottawa: Dept. of Energy, Mines and Resources. 213 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. RA0004

05 0665

Lindsay, D.G. (1977). **Sea ice atlas of Arctic Canada, 1969-1974**. *Ottawa: Dept. of Energy, Mines and Resources. 219 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. RA0004-01

05 0666

Macpherson, M.D. (1980). **National petroleum reserve — Alaska. Marine transportation system analysis**. *Final report. New York: McMullen Assoc. 486 pp.*

Acknowledgement: OEIC
Available from: CRREL: cite no. 35-2575

05 0667

Markham, W.E. (1975). **Ice — climatology of the Beaufort Sea**. *Beaufort Sea project technical report no. 26. Victoria, B.C.: Department of the Environment. 87 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. B00233-26

05 0668

Meserve, J.M. (1974). **U.S. Navy, marine climatic atlas of the world. vol. 1.: North Atlantic Ocean**. *U.S. Navair 50-1C-528. 1 vol.*

Acknowledgement: OEIC
Available from: OEIC

05 0669

Morgan, C.W. (1971). **Iceberg distribution in Baffin Bay and the Labrador Sea as determined from preseason ice patrol flights by the U.S. Coast Guard. Analysis of previous years data. Report of the International Ice Patrol Service in the North Atlantic**. *U.S. Coast Guard Bulletin 56: 28-72.*

Acknowledgement: OEIC
Available from: OEIC: cite no. A00016-70-AA See also Introduction "Availability of documents" items (a) and (b)

05 0670

Peters, S.S. (1978). **Arctic gas from the Arctic High Islands via the marine mode**. *Developing Canada's Resources for all Canadians (Engineering Institute of Canada) 92nd, St. John's, Nfld., v. 2(3): TR. 2/1-10.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00153-92-AH See also Introduction "Availability of documents" item (a)

05 0671

Reimnitz, E. and P.W. Barnes. (n.d.). **Sea ice as a geologic agent on the Beaufort Sea shelf of Alaska**. *Menlo Park, California: U.S. Geological Survey.*

This paper describes some processes and features related to the action of ice in the marine environment of the Beaufort Sea shelf, with emphasis on the processes of ice gouging the shelf surface.

Acknowledgement: CARC
Available from: CARC: cite no. 551-326-7 *62*

05 0672

Robe, R.A., D.C. Maier and W.E. Russell. (1979). **Long term drift of icebergs in Baffin Bay and the Labrador Sea**. *Iceberg Dynamics Symposium, Proceedings, St. John's, Nfld. Cold Regions Science and Technology 1(3, 4): 183-193.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00240-00-AB

05 0673

Roots, E.F. (1972). **Arctic offshore knowledge and research: Sea ice and icebergs**. *Address given at the Northern Canada offshore Drilling meeting, December 5-6, 1972, Ottawa.*

Acknowledgement: CARC
Available from: CARC: cite no. 551.326.7 *41N*

05 0674

Sandkvist, J. (1980). **Observed growth of brash ice in ships' tracks**. *Lulea, Sweden: University of Lulea, Div. of water Resources Engineering. 65 pp. (Research Report Lulea, 1980: 25, Series A no. 42).*

Acknowledgement: OEIC
Available from: OEIC

05 0675

Science Council of Canada. (1977). **Seminar on natural gas from the Arctic by marine mode: A preliminary assessment**. *Ottawa: Science Council of Canada. Atlantic Provinces Economic Council, 1977. 253 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00115 See also Introduction "Availability of documents" item (a)

05 0676

Smirnov, V.I. (1979). Zakonomernosti v pereraspredelenii l'dov

v vodakh zarubezhnoi Arktiki. [**Regularities of sea ice distribution in Arctic waters outside the USSR.**] *Meteorologiia i gidrologiia 11: 109-112. (In Russian.)*

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" item (b)

05 0677
Sowden, W.J. (1980). **Weekly median and extreme ice edges for eastern Canadian Seaboard and Hudson Bay.** *[s.l.]: Environment Canada, AES, Ice Climatology and Applications Division. 56 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. RM0019

05 0678
Walker, M. (1976). **A review of navigation systems and their applicability to the Arctic. State-of-the-art overview.** *Winnipeg, Man.: Canadian Forces Air Navigation School. 76 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. B00741

05 0679
Walsh, J.E. (1979). **Sea ice extent in the Arctic, month to month variation in sea ice extent illustrated by twenty five years of computer maps, 1953-1977.** *Urbana, Ill.: University of Illinois at Urbana - Champaign, Laboratory for Atmospheric Research. (Computer printout).*

Acknowledgement: OEIC
Available from: OEIC: cite no. RA0014

05 0680
Winsor, W.D. and B.R. LeDrew. (1978). **Ice feature characterization — Labrador offshore.** *C-CORE Publication 78-4. 50 pp. Field Data Report.*

Acknowledgement: OEIC
Available from: OEIC: cite no. N00159 See also C-CORE

05 0681
Wright, B. and D. Berenger. (1980). **Ice conditions affecting offshore hydrocarbon production in the Labrador Sea.** *Workshop on Research in the Labrador Coastal and Offshore region, Goose Bay, Labrador, Proceedings (M.U.N., NICOS), 3rd, pp. 307-319.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00202-03-AG

05 0696
Norcor Engineering and Research Ltd. (1978). **A study of ice conditions along marine shipping routes in the Arctic Archipelago.** *Yellowknife, N.W.T.: Norcor, 1 vol. (Canada. Ministry of Transport, TP 1530) Prepared for Strategic Studies Branch, Ministry of Transport.*

Acknowledgement: OEIC
Available from: OEIC: cite no. B00728 See also Introduction "Availability of documents" item (a)

05 0697
Sergeev, G.N. and YU.N. Khromov. (1980). Torosistost' i soprotivliaemost' l'da dvizhushchemusia sudnu. [**Hummocking and resistance of ice to a moving ships.**] *Meteorologiya i godrologiya, no. 10: 100-104. (In Russian with English summary.)*

The paper generalizes principles of calculation of mean thickness of ice cover with allowance for its hummocking; developed by various authors. It is demonstrated that they cannot be utilized for calculating the ice navigability of ships due to the selectivity of the process of ice breaking by a moving ship. A method is suggested for calculating equivalent ice thickness with allowance for hummocking which correspond to the resistivity of smooth ice of a similar thickness.

Available from: See Introduction "Availability of documents" item (b)

05 0703
Acres Consulting Services Ltd. (1979). **Waiting times for crossing of ship tracks.**

Available from: Petro-Canada: cite no. 210

05 0704
Acres Consulting Services Ltd. (1980). **Arctic Pilot Project risk analysis: Melville Island facilities.**

Available from: Petro-Canada: cite no. 364

05 0705
Albery, Pullerits, Dickson & Associates. (n.d.). **Marine transportation of oil and LNG from Arctic Islands to Southern markets.** *Main report. Don Mills, Ont.: Albery, Pullerits, Dickson & Associates.*

Available from: Petro-Canada: cite no. 175

05 0706
Arctec Canada, Ltd. (1980). **Alternate LNG tanker shipping routes to Malloch Bay, Ellef Ringnes Island.**

Available from: Petro-Canada: cite no. 333

05 0707
F.G. Bercha & Associates Ltd. (1979). **Development of risk and reliability models of Arctic marine hydrocarbon production and transportation systems.**

Available from: Petro-Canada: cite no. 409

05 0708
Danish Hydraulic Institute. (1980). **Preliminary physical environmental programme in relation to proposed LNG transport along the West Coast of Greenland.**

Available from: Petro-Canada: cite no. 334 This is an unpublished report.

05 0709
D.F. Dickens Engineering. (1979). **Evaluation of a year-round shipping route to Melville Island through Fury and Hecla Strait.**

Available from: Petro-Canada: cite no. 324 This is an unpublished report.

05 0710
Energy Systems Engineering. (1977). **Polar gas project — Alternative modes of transportation.**

Available from: Petro-Canada: cite no. 009

05 0711
German and Milne. (1976). **Marine mode shipment of LNG from Canadian Arctic to Lower St. Lawrence.** *Transportation Study. Phase I & II.*

Available from: Petro-Canada: cite no. 023 This is an unpublished report.

05 0712

German and Milne. (1977). **Marine mode shipment of LNG from Bridport Inlet & Radstock Bay to Port Hawkesbury, Nova Scotia.**

Available from: Petro-Canada: cite no. 033 This is an unpublished report.

05 0713

German and Milne. (1980). **Risk/Reliability study.** *Volume II & III & IV: Factual information. Volume V: Logical and mathematical definition of the system's reliability. Volume VI: Fault free analysis. Volume VII: Mission simulator and economic model. Volume IX: Computer models. Montreal: German and Milne.*

Available from: Petro-Canada: cite no. 460 See also Introduction "Availability of documents" item (a)

05 0714

I.M.C.O. (1979). **Code of safety for nuclear merchant ships.**

Available from: Petro-Canada: cite no. 209

05 0715

Melville Shipping Ltd. (1977). **The shipment of liquefied natural gas from Melville Island to the Eastern Seaboard — An application for insurance.**

Available from: Petro-Canada: cite no. 006 This is an unpublished report.

05 0716

Melville Shipping Ltd. (1977). **The shipment of liquefied natural gas from Melville Island to the Eastern Seaboard — General summary, vessel design, system performance, finance & economics, and service operations.** *(5 Reports.)*

Availalbe from: Petro-Canada: cite no. 125 These are unpublished reports.

05 0717

Melville Shipping Ltd. (1977). **The shipment of liquefied natural gas from Melville Island to the Eastern Seaboard.**

Available from: Petro-Canada: cite no. 138 This is an unpublished report.

05 0719

Wartsila. (1977). **Ice navigation capabilities of Lunni class icebreaking tankers.** *Helsinki: Wartsila.*

Available from: Petro-Canada: cite no. 189 See also Introduction "Availability of documents" item (a)

05 0720

Gilmour, G.A. and H.M. Gruen. (1978). **Iceberg detection for an LNG tanker for Melville shipping.** *Westinghouse Electric Corp.*

Available from: Petro-Canada: cite no. 153 See also Introduction "Availability of documents" item (a)

06 Model Testing, Simulation Studies, etc.

06 0243

Abdelnour, R. and P. Noble. (1978). **Model test for examining the behaviour of an A.C.I.B. in level ice**. *Kanata, Ont.: Arctec Canada Ltd. 1 vol.*

Available from: TDC Library, Montreal (Interlibrary loan)

06 0244

Chu, F.D. (c1976?). **Ship resistance in homogeneous ice fields**. *Wageningen, Netherlands: Netherlands Ship Model Basin. 125 pp.*

In Chapter I the basic concept of the division of the total resistance in ice is explained. The grouping of the various resistances is justified not only on the ground of their different physical characteristics but also on the ground of the different simulation laws that apply to each group. Chapter II presents a description of the ship models and the model ice. It contains a full discussion of the development of the lines of the six models that were used in the systematic tests. The use of triangular paraffin wax sectors to simulate the broken ice-field is justified on practical as well as theoretical grounds. In Chapter III the physical lay-out of the test facilities and a typical test run are described. The matrix that was used for the data recording is provided. Included in this chapter also are six contours, in which the results of the systematic tests are plotted as resistance per ton displacement versus Froude's number. The concluding Chapter IV deals with the application of the model tests for full scale application. Three standard calculation sheets are provided for the step-by-step computation of the performance of a ship in the ice field. Added to these sheets is a numerical example in which a comparison is made with the full-scale data of the S.S. Manhattan voyage through the Northwest Passage in 1970.

Acknowledgement: MRIS

Available from: Netherlands Ship Model Basin Haagsteed 2, P.O. Box 28 Wageningen Netherlands

06 0245

Coveney, D.B. and W.H. Brierly. (1977). **The cutting of ice with water jets**. *Ottawa, Ont.: National Research Council of Canada, Div. of Mechanical Engineering. Report no. DME-MD-54. 40 pp.*

A new portable, self-contained facility for investigating the cutting of ice with water jets has been built and tested. Following the initial trials some modifications and improvements to the facility have been recommended. From current and previous ice cutting tests it has been established that significant cuts in ice can be made over a wide range of conditions. At moderate pressures, that is less than 2,000 psig, and low traverse speeds, it has been possible to cut through ice 28 inches thick. Correlation with previous test results by regression analysis has been made. (Author)

Acknowledgement: NTIS

Available from: NTIS: cite AD-A051 616/1ST

Price: $6.00 U.S.

06 0246

Cowley, J.E., J.W. Hayden and W.W. Willis. (1977). **Model study of St. Mary's River ice navigation**. *Canadian Journal of Civil Engineering 4(3): 380-391.*

Vessel movements in the river during winter months lead to changes in the river ice regime and affect local ferry service across the river. A hydraulic scale model of a 7300 m length of the waterway extending downstream from the Soo Locks was used to compare alternatives for relieving these effects. Methods for representing ice behavior were a key element in the model study. An arrangement of ice booms with an open ship passage which does not impede navigation was developed and recommended on the basis of model tests. That boom arrangement was installed at the end of 1975 and proved to be highly effective under the ice conditions experienced in the 1975-1976 and 1976-1977 winter seasons.

Acknowledgement: Engineering Index

Available from: See Introduction "Availability of documents" Item (b)

06 0247

Crago, W.A., P.J. Dix and J.G. German. (1971). **Model ice-breaking experiments and their correlation with full scale data**. *Royal Institution of Naval Architects Quarterly Transactions 113 (January): 83-108.*

Available from: See Introduction "Availability of documents" Item (b)

06 0248

DeBord, F.W., J.W. Lewis and R.P. Voelker. (1979). **Ice model tests and computer simulation of propeller-ice impacts of a polar research ship**. *In Proceedings of the 5th International Conference on Port and Ocean Engineering under Arctic Conditions, Trondheim, Norway, August 13-18, 1979, vol. 2, pp. 1023-1040. Trondheim, Norway: The University.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

06 0249

De Bord, F.W. and R.P. Voelker. (1979). **Application of pilot house simulators to ice-transiting merchant ship operations**. *In Proceedings of the Third Annual CAORF [Computer-aided Operations Research Facility] Symposium, Maritime Simulation Research, King's Point, N.Y., October 15-16, 1979. Paper no. 16. 7 p. King's Point, N.Y.: National Maritime Research Center.*

Future development of energy and other natural resources in the Arctic regions of the world will require efficient transportation systems for the movement of liquid and dry bulk cargoes. One system which appears promising is marine transportation using ice-transiting surface ships. The potential for near-term implementation of an Arctic Marine Transportation system is discussed; problems associated with development are identified; and use of realistic pilot house simulations for the solution of these problems is analyzed. It is concluded that pilot house simulations can have a significant impact on both design and operational problems which currently remain unsolved. Finally, the research and development required to develop a realistic simulation of ice-transiting ship operations are identified based on a survey of the current state-of-the-art technology.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Items (a) and (b)

06 0250

Edwards, R.Y. (1978). **Compilation and analysis of recent icebreaking model test data of a world-wide variety of hull forms.** *Kanata, Ont.: Arctec Canada Ltd. 69 pp.*

This report consists of compilation and analysis of data from recent world wide model icebreaking tests of a variety of hull forms. The analysis is aimed at defining those parameters which may influence the icebreaking resistance and developing a prediction approach.

The report describes reclassification of icebreaking resistance, the development of hull geometry friction coefficients, the selection criteria for model data and the statistical analysis using both dimensional and dimensionless variables. In conclusion the findings are summarized and recommendations for further study are made.

The hull parameters and lines plans of the models selected for analysis are presented in two appendices. (Author).

Available from: TDC Library, Montreal (Interlibrary loan)

06 0251

Gordin, S. (1978). **Full scale and model testing of ships' operation in ice.** *Paper no. 4 presented at Third International Offshore Craft Conference, London, September 1978. 11 pp.*

The Author describes in some detail the activities of the Wartsila Arctic Design and Marketing Department (WADAM) in the development of icebreakers and other ice-going ships and associated technologies. The Department is mainly occupied with ship projects for the Wartsila shipyards, but also acts as a consultant; its work extends far beyond the Baltic. The paper is arranged under the main headings: Full-Scale Testing (Ice Conditions, Ice Resistance Tests, Measurements, Propeller Loads and Propulsion System Behaviour, Additional Tests). Model-Scale Testing (Testing Facilities, Ice Conditions, Tests, Analysing and Full-Scale Predicting). Studies on Ship Operation ("Vintbott" (a 1976 study on the operation of icebreakers and merchant ships in the Gulf of Bothnia) Examples of Other Studies). Applications (Icebreaking Capability in Level Ice, Simulation of progress in Ramming Mode, Simulation of the Interaction between Ice and the Propulsion System, Transit Simulation). A drawing is included showing the layout of the Wartsila Icebreaking Model Basin, which was extensively modified in 1976-77.

Acknowledgement: BSRA
Available from: TDC Library Ottawa (Interlibrary loan)

06 0252

Johansson, B.M. and E. Makinen. (1972). **Great Lakes ore carrier series — ice resistance model test program in loaded condition.** *Helsinki, Finland: Wartsila Icebreaking Model Basin. Final report fiscal year 1973. Report no. WIMB-Test-18. 229 pp.*

The object of the model test program was to provide the ship designer with the methodology for designing ships to operate in ice waters. The methodology is to include quantitative relationships between ship form parameters, ice conditions, ship motion and ice resistance for Great Lakes vessel operations in the extended season. The program consisted of the comprehensive testing of nine models of varying bow form, length and beam. The final result is a method for calculating ice resistance in different ice thicknesses and at different speeds for ships with forms similar to those of Great Lakes ore carriers.

Acknowledgement: NTIS
Available from: NTIS: cite COM-74-10424/1
Price: $18.50 U.S.

06 0253

Laine A., B.M. Johansson and E. Makinen. (1973). **Great Lakes ore carrier series — ice resistance model tests in ballast conditions.** *Helsinki, Finland: Wartsila Icebreaking Model Basin. Final report fiscal year 1973. Report no. WIMB-Test-24. 148 pp.*

The object of the model test program was to provide the ship designer with the methodology for designing ships to operate in ice waters. The methodology is to include quantitative relationships between ship form parameters, ice conditions, ship motion and ice resistance for Great Lakes vessel operations in the extended season. The program consisted of the comprehensive testing of nine models of varying bow form, length and beam. The final result is a method for calculating ice resistance in different ice thicknesses and at different speeds for ships with forms similar to those of Great Lakes ore carriers.

Acknowledgement: NTIS
Available from: NTIS: cite COM-74-10425/8
Price: $14.50 U.S.

06 0254

Groddeck, K.H. (n.d.). **Some considerations on the navigation of a bulk carrier in closed ice.** *Hansa. Vol. 113.*

If bulk carriers are to be used to transport raw materials from the Arctic, it must first be determined whether all-the-year-round navigation through closed ice is both possible and economic. To find an answer to this question, the relationship between propulsion power and ship-speed is, together with strength investigations and cost analyses for the ship, of decisive importance. This relationship cannot yet be determined, however, either theoretically or in model tests. The Author discusses the theoretical and experimental aspects of this problem and, in particular, makes some detailed proposals for the design of model-test equipment for relevant experimental work; such work could considerably assist full-scale design studies. It is mentioned that, though the arguments advanced apply to large bulk-carriers, it is not difficult to recognize how far they can also be applied to other types of ship.

Acknowledgement: BSRA
Available from: CISTI (Photocopying service)

06 0255

Jennergren, L.P., L. Lundh and S. Wandel. (1977). **Icebreaking operations in the Northern Baltic a simulation.** *Operational Research Quarterly 28(2): 377-390.*

An icebreaking situation in the Northern Baltic is considered. Two icebreakers are deployed to assist freight ships to and from three harbours in Northern Sweden. This may be considered a rather complex queueing situation. A number of different operating policies for icebreaker assistance are examined by means of simulation. A basic simulation model of winter navigation in the Gulf of Bothnia has been written in SIMULA, which comprises 800-1000 statements, depending on the model version. Ships are assumed to have only one destination, since they are concerned with specialised cargoes such as limestone or iron ore, bound for or coming from particular industrial plants. Among the policy alternatives investigated are different convoy sizes. Some fairly clear policy recommendations are obtained.

Acknowledgement: BSRA
Available from: See Introduction "Availability of documents" Item (b)

06 0256

Johansson, B.M. and E. Makinen. (1973). **Icebreaking model tests: systematic variation of bow lines and main dimensions of hull forms suitable for the Great Lakes.** *Marine Technology 10(3): 236-243.*

Nine bulk carrier models were tested in the Wartsila Icebreaking Model Basin (WIMB) in Helsinki, Finland. Eight of the models form a series with systematically varying parameters. This test series was the first one in which the influence of bow form, ship length and, ship beam on ice resistance was investigated systematically. The basic form was that of

the existing Great Laker SS Ryerson, which was not originally designed for navigating in ice. The other models were modified in order to improve their icebreaking capability. The main objective was to study the ice-breaking resistance in level ice, but in addition some tests were made for determining the ice resistance in a broken channel and for determining the steering ability of the models. All models were tested in level ice of 1, 2 and 3 ft thickness and at a speed range of 0-12 knots. Finally, a method for the calculation of the ice resistance and necessary power level of the Great Lakers is presented.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

06 0257

Kloppenburg, M. (1975). **Ice resistance of a cargo vessel in the continuous mode of icebreaking: tests of three geosim models in ice.** *In Proceedings of the Ice Tech Symposium, Montreal, Canada, April 9-11, 1975, pp. L1-L12. New York, N.Y.: Society of Naval Architects and Marine Engineers, 1975.*

During the last two years three geometrical similar models of an ice-breaking cargo vessel have been tested in the continuous mode of icebreaking. The analysis was done according to three different formulas for the resistance, published in recent literature. The formula which best explains the phenomena physically looks to be the most reliable one. Consequently this formula was used for predicting the ice resistance of the ship.

Acknowledgement: SNAME
Available from: SNAME

06 0258

Kloppenberg, M. and J. Schwarz. (1975). **New methods in icebreaking.** *Jahrbuch der Schiffbautechnischen Gesellschaft Vol. 16: [n.p.] (In German.)*

Following a brief general history of icebreakers and their differing operational roles, research and development in icebreaking technology since 1950 is reviewed. Model testing techniques in use at the icebreaking tank of the HSVA are described. The properties of synthetic ice and natural ice are compared and a description is given of an experimental programme using the cantilever beam of the HSVA tank to determine the relationship between the flexural strength, elasticity, salt content and temperature of salt-water ice. The results are compared with the theoretical work of Assur and Weeks.

Acknowledgement: BSRA
Available from: BSRA See also Introduction "Availability of documents" Item (d)

06 0259

Kotras, T.V., J.W. Lewis and D.C.N. Robb. (1975). **St. Lawrence Seaway: a new goal of year-round navigation.** *In Symposium of Modelling Techniques, 2nd, San Francisco, 1975, Vol. 1, pp. 1-22. New York: American Society of Civil Engineers, 1975.*

Available from: See Introduction "Availavility of documents" Items (a) and (b)

06 0260

Kotras, Thomas V. and James J. Peter. (1980). **Computer simulation of Great Lakes-St. Lawrence Seaway icebreaker requirements.** *Columbia, Md.: Arctec Inc. 193 pp.*

Available from: See Introduction "Availability of documents" Item (a)

06 0261

LeCourt, E.J. et al. (1973). **Mechanical ice cutter design and testing of 1/6th scale model.** *Columbia, Md.: ARCTEC Inc. Final report. 181 pp.*

The report covers the last phase of the development of a 1/6 scale (24 ft) model of a unique mechanical ice cutting and ice displacement concept for clearing ice free channels at a full scale target speed of 5 knots in 2 ft of fresh water ice. The mechanics of ice cutting are analyzed. The theoretical ice breaking and ice removing resistance is also modeled mathematically and scaling laws are included in the analysis. A recount of winter 1973 tests in a Pennsylvania Lake describes the instrumentation and data as well as the operation of an ice traction system used to replace conventional marine propulsion. Full scale performance and design are also predicted in detail. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-766975/7

06 0262

Lewis, Jack W. (1972). **Ship model ice resistance experiments: air bubbler hull lubrication for 1/20 scale model of SUNDEW:** *Columbia, Md.: ARCTEC Inc. Final technical report Sept 71-Oct. 72. Report no. TR-0029. 301 pp.*

The report discusses the problem of defining icebreaking performance and model tests used to measure performance. The influence of the ice variables on performance are discussed in some detail and set the stage for discussions of the influence of auxiliary icebreaking devices on performance. A summary of principle conclusions and recommendations ends the report. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-754 977
Price: $17.00 U.S.

06 0263

Major, Robert A. (1977). **Model tests in ice to confirm effectiveness of the 140-foot WYTM air bubbler system.** *Columbia, Md.: ARCTEC Inc. Model test report. Report no. 354C-2. 106 pp.*

A 1/24th scale model of the 150 ft. WYTM was equipped with an air bubbler system. The bubbler system was operated at various flow rates from no flow to twice the nominal system capacity. Tests were performed in both solid ice and brash to determine the effectiveness of the bubbler system in reducing the power required to transit ice fields. In all cases, a flow was found which reduced the total power from that required for a ship without the air system. This model test formed the basis for designing the air bubbler system for the Coast Guard 140' class of icebreaking tugs. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-A084 623/8 microfiche copies only
Price: $3.50 U.S.

06 0264

Richardson, C. (1969). **Model study of icebreaker operations.** *Naval Engineers Journal 81(5): 13-14, 18-26.*

A towed icebreaker model driven up onto a roller which substitutes for the edge of the ice sheet is used to study an icebreaker approaching a semi-infinite ice sheet from an area of open water, at a constant rate of speed. Since the vertical forces produced under these conditions are one of the indicative parameters for describing an icebreaker's potential for breaking ice, the roller is instrumented to measure the forces exerted by the impinging model. The conditions for similitude are determined by dimensional analysis. The experimental data are discussed and related to measurements made on actual icebreakers during ramming operations.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

06 0265

Schwarz, J. and L. Hoffman. (1978). **Icebreaking with models**

and on full scale. *Jahrbuch der Schiffbautechnischen Gesellschaft 72: 207. (In German.)*

After a brief general discussion of research on icebreaking, the Authors give an account of the 1977 research voyage of the twin-screw icebreaking supply-ship Werdertor (1,495 tons displacement) off Spitzbergen, together with an account of tests with a model of this ship in the HSVA ice-tank. The voyage was a co-operative effort by the ship's operators (the Offshore Supply Association), Germanischer Lloyd, the Jastram company, and the HSVA. The full-scale research programme, under the guidance of the HSVA, was an extensive one, and the results presented in the paper are mostly those relevant to model/ship correlation. (for the manoeuvring tests on the Werdertor in ice, one of the ten items in the research programme.) In model tests on icebreaking ships, most experimental ice-tanks have concentrated on resistance tests; however, the HSVA carries out propulsion tests in ice as a standard procedure. How accurately the model results can be correlated with the full scale has been a difficult question, and the present work has, for the first time, provided full-scale propulsion results for a ship whose model results were available; the discrepancies between model and full scale were below 10%. These investigations have inter alia confirmed that, because of the effect of ice upon propeller efficiency, model tests for power-requirement predictions must include propulsion tests in ice. A brief account is included of tests, during the research voyage, of a system developed by Jastram and the HSVA for reducing frictional resistance of ships (and offshore structures) in ice. The system employs an air-water mixture which is pumped out through jets in the ship's forebody. Although the results of the model/full-scale comparisons have been satisfactory, the Authors recommend that every opportunity should be taken for making further comparisons. A theoretical basis for the icebreaking processes should also be sought; work to this end is proceeding at the HSVA.

Acknowledgement: BSRA
Available from: BSRA: cite no. 52,293 See also Introduction "Availability of documents" Item (d)

06 0266

Vance, G.P. (1968). **Model testing in ice**. *Naval Engineers Journal 80(2): 259-264.*

Available from: See Introduction "Availability of documents" Item (b)

06 0267

Vance, George P. (1975). **Modeling system for vessels in ice**. *(Ph.D. Thesis, Rhode Island University. Dept. of Ocean Engineering). 367 pp.*

The report covers the existing methods utilized in scaling model data for vessels in ice to the full scale regime. It reviews the properties of model and full scale ice. The main thrust of the report is the development of a procedure for testing vessels in model ice and scaling the results to the full scale regime with an accuracy of plus or minus 10 percent. The second section of the report discusses the design of a test facility to conduct icebreaking and hydrodynamic model tests. All the data collected and utilized are contained in appendices to the report.

Acknowledgement: NTIS
Available from: NTIS: cite AD-A013 807/3ST
Price: $19.00 U.S.

06 0268

Vance, G.P. (1975). **A scaling system for vessels modeled in ice**. *Paper presented at the Ice Tech Symposium, Montreal, Quebec, April 9-11, 1975.*

This paper presents the rationale and the technique used to derive an equation that can be utilized to scale the results of resistance model tests run in ice to the full scale regime. The equation was obtained, utilizing stepwise multiple regression analysis techniques on model and full scale data available for five different icebreaking vessels.

The results indicate that full scale resistance can be predicted to within 10 percent of measured prototype values. The technique is applicable to homogeneous ice sheets under neutral pressure conditions, i.e. no adverse pressure fields exist. The effects of the coefficient of friction is also taken into account.

Acknowledgement: SNAME
Available from: SNAME

06 0269

Virtanen, J. et al. (1975). **Great Lakes ore carrier series ice resistance model tests draft variation**. *Helsinki, Finland: Wartsila Icebreaking Model Basin. Report WIMB-Test-34. 94 pp.*

Available from: See Introduction "Availability of documents" Item (a)

06 0270

Voelker, R.P. and J.K. Kim. (1976). **Summary results of ice resistance tests for Great Lakes bulk carriers from the Wartsila model test series**. *Columbia, Md.: ARCTEC Inc. Final report. Report no. 160C-1. 372 pp.*

This report summarizes the results from the Wartsila parametric model test series in which the ice resistance of variations in the ice-breaking bows of Great Lakes bulk carriers was determined in both level and broken ice. Part I of this report summarizes the test results and provides a sample calculation. Part II of this report is a consolidation of the original five Wartsila reports.

Acknowledgement: NTIS
Available from: NTIS: cite PB-281695/7ST

06 0271

Voelker, R.P. and J.K. Kim. (1978). **Test and evaluation of ice transiting bow forms for Great Lakes bulk carriers**. *Columbia, Md.: ARCTEC Inc. Report no. 160C-3. 156 pp.*

The purpose of this project was to design, test and evaluate several ice transiting bow forms for Great Lakes bulk carriers. Tasks within the project included the design of four ice transiting bow forms, the conduct of open water and ice resistance tests (level and broken ice) and an economic evaluation of the bow forms. In addition, a limited number of maneuvering tests in ice were performed along with the measurement of ice impact forces on the model.

Acknowledgement: NTIS
Available from: NTIS: cite PB-281-697/3ST

06 0272

Wilson, S.R.G. (1977). **Statistical study of passage into Beaufort Sea via Point Barrow**. *Calgary, Alta.: Arctic Petroleum Operators Association. Report no. APOA 113-1. 108 pp.*

The purpose of this study was to determine the probability of successfully transporting a large, deep draft vessel from the Pacific Ocean, via Point Barrow, Alaska, to MacKenzie Bay in the Southeast Beaufort Sea, during any given summer season. Specifically, the purpose was to evaluate transportation through those areas where the transportation depends on sea ice conditions, for minimum water depths of 20, 30, and 40 feet. For the most realistic cases (i.e. 3 knots in open water, 2 knots in 1 to 3 tenths ice cover, 1 knot in 4 to 6 tenths ice cover, 0 otherwise, for minimum water depths of 20, 30, and 40 feet) the simulations showed success in every year but 1975, of the 16 years 1962 to 1977, inclusive, for a probability of success of 94%. This compares well to the estimates of experienced people, who suggested probabilities of success between 88% and 97%. The simulations confirm the expected result that the higher the vessel speed, the lower the minimum water depth, and the greater the capacity for travel through ice, the greater will be the success rate for a given starting date, and the shorter the average travel time. (Author).

Acknowledgement: APOA
Available from: APOA
Price: $25.00 (photocopy) $8.50 (microfiche)

06 0273

Wood, C.D. (1970). **Analysis of explosive icebreaker**. *San Antonio, Texas: Southwest Research Institute. Final report. Report no. SwRI-AR-751. 36 pp.*

The feasibility of an explosive icebreaking and water flush ice removal technique is analyzed. Both calculation and model test results indicate a high degree of feasibility for these concepts. (Author).

Acknowledgement: NTIS
Available from: NTIS: cite AD-710 193
Price: $6.00 U.S.

06 0682

Consultec Inc. (1969). **Feasibility of tanker operations in Arctic ice**.

THe report covers the question of feasibility from the development of a suitable ship form, to the necessary modifications to a tanker and related structural analysis. Subjects covered include the mathematical model of icebreaking, model testing, environmental data (especially ice growth and concentration), friction of materials and ice, propeller and shaft loads and structural analysis.

Acknowledgement: Esso Resources Canada Ltd.
Available from: Exxon USA Atlantic Richfield Co. BP Oil Co. This is an unpublished report.

06 0683

Edwards, R.Y. (1979). **Modelling of ice-problems: Interaction between ice & ships**. *IUTAM Symposium on the Physics & Mechanics of Ice, preprints, Copenhagen, Denmark. 2 p.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00214-00-AE

06 0684

Edwards, R.Y. and J.W. Lewis. (1970). **Modelling the motion of ships through polar ice-fields using unconstrained, self-propelled models**. *Ice Symposium, Reykjavik, Iceland. 18 pp.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00029-01-46

06 0685

Nawwar, A.M. (1977). **Compilation and analysis of recent icebreaking model test data of a world-wide variety of hull forms**. *Kanata, Ont.: Arctec. TP 1294.*

The amount of accumulated ice model data has increased greatly since 1971. However existing mathematical models used to predict icebreaking resistance do not give satisfactory results and input parameters are suspect.

This project has compiled data currently available from model tests of 37 hull forms into consistent units so as to assess their reliability and enable regression analysis. A mathematical model was produced which corresponds to the observed results with reasonable accuracy. The model has also been compared to full scale test data taken from the CCGS "Wolfe" evaluation.

Available from: TDC Library, Montreal

06 0698

Abdelmour, R. (1980). **Model tests of an icebreaking inclined plane**. *Presented at the 1980 annual conference of the Canadian Society for Civil Engineering, Winnipeg, May 1980.*

An experimental program was carried out at a scale $\gamma = 30$ on two inclined plane models. A total of 60 runs, using four ice sheets, were conducted in which the thickness (η), the towing speed (μ) of the ice relative to the models, and the slope (α) were varied. The horizontal and vertical resistance force seen by each of the two structures were measured. The ice failure mode and the ice clearing around structures were monitored and recorded. The results of the tests were presented and subsequent analysis was made.

The effect of most influencing parameters varied during the model experiments, were introduced through a dimensionless relationship where force prediction can be made possible.

Available from: Arctec

06 0721

Arctec Inc. (1978). **Results of the model tests of the LNG carrier in Bridport Terminal**. *Final report 280C-3. Columbia, Md.: Arctec.*

Available from: Petro-Canada: cite no. 282 See also Introduction "Availability of documents" item (a)

06 0722

Melville Shipping Ltd. (1978). **Wartsila icebreaking model Basin WIMB — Ridge resistance tests of an Arctic LNG carrier**. *Test Report No. A51.*

Available from: Petro-Canada: cite no. 321

06 0723

National Research Council Canada — Marine Dynamics & Ship Laboratory. (1978). **Maneuvring tests including iceberg avoidance maneuvres with a model of an Arctic Class LNG carrier (Model 322)**.

Available from: Petro-Canada: cite no. 204

07 Navigational Aids and Data Gathering (on Board)

07 0274

Cobb, I. and A.D. Dunsiger. (1977). **Electronic beam stabilization and scanning of hull mounted echo sounders**. *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions, Memorial University of Newfoundland, St. John's, Nfld., September 26-30, 1977, v. 2, pp. 1100-1110. St. John's, Nfld.: The University, Ocean Engineering Information Centre, 1978.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

07 0275

German, J.G. (1979). **M.V. Arctic instrumentation and data collection system for ship operations in ice: system operating and user's manual**. *Summary report. Montreal, Quebec: German and Milne Inc. 11 pp. (Canada. Ministry of Transport. Report no. TP 2218)*

The report provides a detailed description of an Instrumentation System which was installed in the Motor vessel "Arctic" during the period July 1977 to July 1979. This system is designed to provide a record of the ship's operational experience when navigating in ice, both in terms of the prevailing environmental conditions and the ship's performance and response. The system includes an array of strain gauges permanently attached to the ship's hull at the bow and amidships. Signals in analog form are relayed from these gauges and other special sensors to the CPU, then recorded in digital form on 9 track mag tape for subsequent analysis. Records of hull strains due to ice impact and frequency of impact, together with ship machinery parameters (such as shaft RPM and fuel rack setting, torque, thrust and propeller pitch) and ship speed, direction and motions are obtained with this system, in automatic, semi-automatic or fully supervised modes.

Available from: TDC Library, Montreal (Interlibrary loan)

07 0276

Haines, S.A. (1980). **Plotting through the pack: radar resistant ice**. *Science dimension 12(3): 16-19. (In English and French).*

Available from: See Introduction "Availability of documents" Item (b)

07 0277

Parsons, S.R. (1974). **Is man really necessary? Some reflections on electronic navigational aids**. *Shipping World and Shipbuilder 167(3890): 230-231, 233.*

Available from: See Introduction "Availability of documents" Item (b)

07 0278

The perils of Iceberg Alley. *(1980). Marine Engineering Log 85(11): 88; 90.*

Available from: TDC Library, Ottawa (Photocopying service)

07 0279

*Shamkin, L.A. (1979). Osobennosti primeneniia doplerovskogo gidroakusticheskogo laga pri ledovom plavanii. [***Using Doppler hydroacoustic recorder in ice navigation***.] Leningrad Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1979 Vol. 245: 58-63. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

07 0280

Sodhi, D.S. et al. (1977). **Estimation of ice forces on the hull of M.V. Arctic Explorer by strain gauge measurements**. *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions, Memorial University of Newfoundland, St. John's, Nfld., September 26-30, 1977, vo. 2, pp. 475-484. St. John's, Nfld.: The University, Ocean Engineering Information Centre, 1978.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

07 0281

*Tsurikov, V.L. (1965). Ispol'zovanie radiolokastsii pri ledovykh nabliudeniiakh s sudov. [***Use of radar in ice observation from ships***.] Moscow: Nauka. (In Russian.)*

Available from: See Introduction "Availability of documents" Item (a)

07 0686

Blake, P.J. (1980). **Recent development in navigational buoys for use in ice conditions**. *Decade of the Oceans, Washington, D.C. Proceedings of the Annual Conference of the Marine Technology Society, 16th, pp 182-185.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00005-16-AO

07 0687

McClain, E.P. and R.J. Derycke. (1974). **Sea-ice motion along the Labrador Coast as observed by satellite**. *AGU Meeting, Washington, D.C. 2 p.*

Acknowledgement: OEIC
Available from: OEIC: cite no. E00895

07 0699

JMR Instruments Canada Ltd. (1980). **Drill ship navigation and guidance system — operational description**. *Calgary: JMR Instruments Canada. 26 pp. JMR Doc. No. 80204.*

Acknowledgement:
Available from: See Introduction "Availability of documents" item (a)

07 0724

Lapp, D. and L. Arsenault. (1978). **Ice coverage from satellite imagery data acquisition, interpretation & analysis 1972-1978 alternate route study for an LNG tanker**. *Kanata, Ont.: Arctec Canada.*

Available from: Petro-Canada: cite no. 154 See also Introduction "Availability of documents" item (a)

07 0725

Intera Environmental Consultants Ltd. (1977). **A.P.P. Remote sensing overflight data acquisition and reduction program for Melville Shipping Ltd.**

Available from: Petro-Canada: cite no. 147

07 0726

Melville Shipping Ltd. (1978). **Summary of first Arctic flight data interpretation.**

Available from: Petro-Canada: cite no. 310

07 0727

Melville Shipping Ltd. (1978). **Remote Sensing program — Second flight.**

Available from: Petro-Canada: cite no. 317

07 0728

Melville Shipping Ltd. (1978). **Remote sensing program. Summary of the third Arctic flight data interpretation.**

Available from: Petro-Canada: cite no. 318

07 0729

MPB Technologies Inc. (1977). **Development of sea ice thickness sensors: part I: recommended programme.** *Ste. Anne de Bellevue, Que.: MPB Technologies Inc. 1 volume. (Canada. Ministry of Transport. TP 1277).*

A requirement exists for an all-weather instrument to measure from a remote location the thickness of sea ice. Such a sensor would be an asset to the Canadian Coast Guard on its icebreaker helicopters and to the Atmospheric Environment Service Ice Reconnaissance group on its Electra ice patrol aircraft. The ability to obtain information on the distribution and thickness of sea ice along the eastern seaboard and in the Arctic would help ice navigation, permit extension of the shipping season and improve navigation safety.

A number of different techniques have been used for the remote measurement of ice thickness. Some success has been achieved in building prototype instruments that measure fresh water ice, but to date no satisfactory method has been found for the remote measurement of sea ice thickness. This is due to the unpredictable dielectric constant of sea ice at the UHF radio frequencies generally used in remote ice thickness sensing.

TDC has defined a program in which researchers will determine suitable concepts for an airborne remote measuring sensor, design and build an experimental prototype and conduct the necessary experiments to validate the measuring accuracy of the device. Based on the experimental results, a development program for an operational prototype will be outlined for consideration and possible implementation.

Small study contracts were awarded to three firms to identify the most promising measuring techniques. After an investigation of several possible design approaches, it was decided to proceed with a combined synthetic pulse/impulse radar. MPB Technologies Inc. has designed and built experimental radar equipment based on this radar. The equipment is expected to permit the accurate measurement of sea ice varying in thickness from 0.5 m to 3 m, with an effort to be made at achieving a measurement range of 0.3 m to 6 m.

Laboratory experiments demonstrated the ability of the dual mode radar to measure ice thickness from 0.4 m to 3 m using a transmission line antenna. Limited field tests, conducted using a standard antenna corroborated the laboratory findings.

Available from: TDC Library, Montreal

07 0738

German & Milne Inc. (1969). **Arctic transportation feasibility study.** *3 vols.*

In 3 volumes, the report covers ice type and concentration for sections and areas of the Northwest Passage for time intervals dictated by changes in ice cover; the climatological and meteorological data for each area; routes, navigation and equipment, nomenclature and features of ice, the identification of North Slope harbours and the training of ships masters.

Acknowledgement: Esso Resources Canada Ltd.

Availalbe from: Imperial Oil Ltd. Atlantic Richfield Co. BP Tanker Co. Ltd. Exxon USA

08 Propulsion Systems and Technology

08 0282

APE-Allen Gears Ltd. (1979). **Design study: combined epicyclic/parallel shaft gearbox for marine propulsion: triple screw icebreaker project.** *Pershore, Worcester, England: APE-Allen Gears Ltd. 19 pp.*

Available from: TDC Library, Montreal (Interlibrary loan)

08 0283

Airaksinen, K. and M. Marttila. (1976). **On propulsion of icebreakers.** *International Shipbuilding Progress 23(262): 194-202.*

The performance of a diesel-electric propulsion system is compared with other propulsion systems with special consideration of geared diesels and controllable pitch propellers. The influence of ice loads on the choice of icebreaker screw parameters and strength requirements are discussed.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

08 0284

*Aksel'rod, S.B. and A.M. Goloviznin. (1971). Regulirovanie temperatury okhlazhdaiushchei vody paroturbinnykh ustanovok sudov ledovogo plavaniia. [***Control of cooling water temperature for steam turbines of ships designed for ice navigation.***] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1971 Vol. 136: p. 58-66. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

08 0285

*Aleksandr, M.L. (1973). Puti povysheniia nadezhnosti sistemy okhlazhdeniia paroturbinnoi ustanovki v usloviiakh ledovogo plavaniia. [***Improving the reliability of cooling systems for a steam turbine for navigation in ice.***] Sudostroenie August 1973 (no. 8): 28-30. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

08 0286

Appleton, A.D. and T.C. Bartram. (1978). **Place for superconducting D.C. machines in marine propulsion.** *In Proceedings of the International Cryogenics Engineering Conference. 7th, London, Eng., July 4-7, 1978, pp. 270-275. Guildford, Surrey, Eng.: IPC Science and Technology Press Ltd., 1978.*

Superconducting dc machines have been under development for a number of years and it has become apparent that marine propulsion is an application where these machines may show a great advantage. This paper discusses the special features of the motors which allow them to achieve a performance which is beyond that of any other electrical machine. Special reference is made to ice breakers including a discussion on the power and control systems. This study comments on progress in this field and suggests likely trends in the future.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Items (a) and (b)

08 0287

*Avik, IU.N. et al. (1975). Grebnye elektricheskie ustanovki: spravochnik. [***Electric propeller drives: a manual.***] (In Russian with abridged English table of contents enclosed.) Leningrad: Sudostroenie. 320 pp.*

Available from: See Introduction "Availability of documents" Items (a) and (d)

08 0288

*Barshai, Iu.S. and E.IA. Gorbunov. (1975). Dinamicheskie nagruzki v glavnykh elektrodvigateliakh ledokola "Kiev". [***Dynamic loads on the principal electromotors of the icebreaker "Kiev".***] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1975 Vol. 202: 98-107. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

08 0289

Burnett, R.F. (1980). **Internal ducted propulsion system applicable to ice conditions.** *Naval Architect, Mar. 1980 No. 2: 53-54.*

Available from: CISTI (Photocopying service)

08 0290

Dalvaeg, T. (1980). **Slow, controlled pitch.** *Canadian Shipping and Marine Engineering 51(4): 21-22.*

The design concept of a slow-turning KaMeWa controlled pitch propeller (CPP) with a diameter of 7.2 m fitted beneath a semitunnel stern for a new vessel being built at Port Weller Dry Docks for Upper Lakes Shipping Limited is discussed. The gain in efficiency, compared with a more conventional vessel also being built and also fitted with KaMeWa main propellers, is = 8%, partly due to increased maneuverability and the elimination of the need for tugs. Other applications favoring the slow-turning propeller and the CPP principle due to rising costs of fuel and manpower on ferries, ships operating in restricted waters, tugs, and ships operating in heavy ice are assessed. (FT)

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

08 0291

Edwards, R.Y. and R.J. Allan. (1978). **YPASS propulsion system evaluation.** *Kanata, Ontario: Arctec Canada Ltd. 1 vol.*

Availalbe from: TDC Library, Montreal (Interlibrary loan)

08 0292

Electric power in ships-she'll conquer the ice pack easily: Polar Star. *(1973). Marine Engineering Log 78 (April 1973): 42-43.*

Available from: TC Library, Ottawa (Photocopying service)

08 0293

Gerasimov, K.M. et al. (1976). **Manufacture of forgings for the propeller shafts of nuclear icebreakers.** *Soviet Shipbuilding 1976 No. 2 (Pub. Aug. 1976): 56-59.*

Available from: See Introduction "Availability of documents" item (b)

08 0294

Hamilton, Fred M. (1980). **Longitudinal stiffness analysis for the propulsion shafting systems of the polar class icebreakers.** *Naval Engineers Journal 92(2): 179-195.*

Available from: See Introduction "Availability of documents" Item (b)

08 0295

Huzil, N.W. (1980). **Propulsion system vibration test and evaluation report USCGC KATMAI BAY.** *Bethesda, Md.: David W. Taylor Naval Ship Research and Development Center. Research and Development report Apr. 78 - Mar. 80. Report no. DTNSRDC-80/030. 25 pp.*

Alternating thrust, torque, and thrust bearing housing vibration were measured on United States Coast Guard Cutter (USCGC) KATMAI BAY during open water, brash ice, and ice breaking operations. For open water operation the propulsion system complies with all requirements of MIL-STD-167-2. Longitudinal and torsional natural frequencies of the propulsion system were identified. The statistical distribution of peak alternating thrust amplitudes due to brash ice operation was found to be skewed and therefore not normal or Gaussian. (Author).

Acknowledgement: NTIS

Available from: NTIS: cite AD-A081 599/3

Price: $5.00 U.S.

08 0296

Hydrodynamic reduction gears for ice-breaking vessels. *(1979). Shipbuilding and Marine Engineering International 102(1228): 191-192.*

Three basic designs developed by AG Weser as alternatives to conventional diesel-electric and turbo-electric transmission systems are diagrammed and described: Vulcan reduction gears with mechanical lock-up. Vulcan reversing gear, and torque converted marine reduction gear. The three fulfill all general and special requirements for icebreaking vessels' use and differ only in parameters of operating periods in ice and of ice thickness with which they can reckon. The gears with mechanical lock-up consist of a precision quill shaft type gear with integral Vulcan fluid couplings and flexible clutches connected in parallel. The reversing gear consists of 2 hydraulic couplings and a quill shaft; selective filling and draining of the couplings produces reversal. The torque converter reduction gear consists of a multi-stage precision gear with integral torque converters and lock-up clutches for high efficiency (= 96%) in open waters. (FT)

Acknowledgement: Oceanic Abstracts

Available from: See Introduction "Availability of documents" Item (b)

08 0297

An internal ducted propulsion system applicable to ice conditions. *(1980). Naval Architect (March 1980): 53.*

A ship-propulsion system contained wholly within the hull would afford protection from ice and offer advantages for icebreakers and other ships that operate in severe ice. Such a system, the YPASS ducted propulsion system, has been developed by Central Design & Drafting Ltd., of Montreal; it was approved in principle by Lloyd's Register in 1975, and is the subject of a British patent application. In addition to protection from ice and other objects, it offers advantages in manoeuvrability and propulsion. Model tests have given encouraging results, and further tests being carried out at Ottawa may lead to full-scale ship applications.

The YPASS duct system is Y-shaped, with a duct (fitted with a flow-controlling scoop) on each side of the hull, near the stern; these two ducts are connected to a common duct which leads to an outlet at the stern and which houses two (or more) impellers on separate shafts (two overlapping impellers are shown in an explanatory diagram). These impellers, which could be either c.p. or f.p. propellers of about two-thirds the normal diameter, are driven through separate or common gearboxes (relative rotative efficiency is believed to be an optimum at 1 1/2 to 2 times conventional propeller rpm). Just forward of the duct outlet at the stern, two linked rudders are arranged within the duct and provide a high turning-moment for ahead manoeuvring; in each of the side ducts there is a butterfly valve (feathered when going ahead) which may be used to close or throttle the duct and thus deflect the outflow more to one side than the other when manoeuvring astern (the duct "outlet" at the stern is the inlet when going astern).

The article gives further information on the YPASS system and its characteristics, including its manoeuvring capabilities (which might be of benefit to large tankers, and which include directional control during an emergency stop), bollard pull (a thrust of about 1.65 times that of a conventional propulsion system is claimed), ship behaviour in rough weather, vibration (there should be no unbalanced forces), noise (the ducts could have noise insulation), hull form (afterbody fullness could be much increased, and this would overcome loss of buoyancy due to the ducts), and other features.

Acknowledgement: BSRA

Available from: CISTI (Photocopying service)

08 0298

*Iudovin, B.S. (1973). Usloviia primeneniia turbozubchatykh agregatov na sudakh ledovogo plavaniia. [***Applications for turbogear assemblies of ships navigating in ice.***] Sudostroenie October 1973 (no. 10): 22-26. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

08 0299

*Iudovin, B.S. and A.I. Gitel'man. (1976). Issledovanie dinamiki gazoturbinnoi ustanovki pri plavanii sudna vo l'dakh. [***Studying the dynamics of gas turbine installations for ice navigation.***] Sudostroenie July 1976 No. 7: p. 36-38. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

08 0300

*Ivanov, S. (1980). Ledokol s VRSh nadezhnee. [***Icebreakers with controllable propellers more reliable.***] Morskoi flot, 1980 No. 2: 32-33. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

08 0301

*Ivanov, S.N. (1979). Trebovaniia k VRSh sudov aktivnogo ledovogo plavaniia. [***Requirements for controllable propellers of ice navigation ships.***] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1979 Vol. 243: 122-132. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

08 0302

Kazak, M.A. (1978). Konstruktivnye i ekspluatatsionnye osobennosti vlazhnoparovykh turbin. [**Design and operating features of wet steam turbines.**] *Energomashinostroenie 4: 33-38. (In Russian.)*

Principal data on the main turbine power units of Soviet nuclear ice breakers are given and specific features of operation of these turbines under severe conditions of the Arctic are described. Sections of main turbine units are given. In Russian.

Acknowledgement: Engineering Index
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

08 0303

Kazak, M.A., and I.P. Faddeev. (1978). Vlazhnoparovye turbiny atomnyky energeticheskikh ustanovok ledokolov "LENIN", "ARKTIKA" i "SIBIR". [**Wet steam turbines for nuclear power plants of the "LENIN", "ARKTIKA" and "SIBIR" icebreakers.**] *Teploenergetika 7(July): 50-54. (In Russian.)*

Principal data on the main turbosets of Soviet nuclear-powered ice-breakers are presented. They have been generalized on the basis of published data. Specific features of operation of the turbines under ice conditions in the Arctic are described. In Russian.

Acknowledgement: Engineering Index
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

08 0304

Koch, R.L. (1970). **Electrical transmission systems for Arctic tankers**. *Marine Engineer and Naval Architect 93(1135): 451-457.*

The use of ice breaking tankers to sail through the northwest passage has raised questions about various types of main propulsion. A propulsion plan for this application must have characteristics not normally required for large cargo ships and tankers. These special features make electric transmission a definite candidate for this propulsion plant. Some of these features are ease of control, flexibility of installation, multiple use of generators, combining prime movers, non-reversing prime mover propeller reversal is accomplished electrically so that full power is available in the ahead rotation or astern rotation, speed reduction prime mover to propeller. Four different electric transmission systems were considered for this application. These transmission systems are ac rectified dc, ac variable frequency, ac cycloconverter, and dc acyclic.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

08 0305

Lipatov, V.N. and V.I. Lobos. (1973). **Measurement of the thrust of screw propellers by a tensometer thrust gage**. *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp 252-257.*

Available from: See Introduction "Availability of documents" item (a)

08 0306

MacCallum, J.B. (1972). **Application of gas turbines for the propulsion of an ice-breaker: summary of gas turbine generator drive for ice-breaking application**. *Motor Ship 52(March): 517-519.*

Available from: TC Library, Ottawa (Photocopying service)

08 0307

Mathews, S.T. (1975). **Aspects of the propulsion power of Arctic vessels, considering their operating environment**. *In Proceedings of the Ice Tech Symposium, Montreal, Canada, April 9-11, 1975, pp. A/1-A/12. New York, N.Y.: Society of Naval Architects and Marine Engineers, 1975.*

The paper applies ice resistance technology to the calculation of design powers and icebreaking performance. There are five main sections: 1. Operating Environment and Ship Classes, reference is made to the Canadian Government Arctic Shipping Pollution Prevention Regulations and the Ship Classes Zones and Seasons as these items are connected with the environment. A description is also given of conditions during the severe ice season in zone 13 when an experimental voyage was in progress. 2. Ice Resistance, Inertial Ice Breaking Capability (Penetration on Stopping), Thrust and Power, an exact formula is developed for the penetration on stopping. This is related to ship speed and a minimum value proposed for design purposes. The present status of ice resistance technology is described in this section. 3. Minimum Design Power Calculations for Various Ships, the results developed in section 2 are applied to assess the icebreaking capabilities of the vessels. 4. Arctic Class Numbers, the icebreaking capabilities calculated in section 3 are related to the ship Classes. 5. Concluding Remarks, here a summary is made of the main points brought out in the other sections and suggestions are made of various formulae as design guides. The need for continued model and full scale research and for operations data is indicated.

Acknowledgement: SNAME
Available from: SNAME

08 0308

Mitsevich, A.T. and L.N. Muchnik. (1967). **Operating experience of ships with atomic power plants**. *Washington, D.C.: Joint Publications Research Service. 22 pp. (Translation).*

The article describes the function, design and operation of the atomic icebreaker "Lenin". Its development has increased the length of the navigation season. A discussion of the safety of the design is included.

Acknowledgement: NTIS
Available from: NTIS: cite JPRS-43550
Price: $5.00 U.S.

08 0309

Noble, P. and V. Bulat. (1980). **Ice rules for propellers and propeller shafting**. *Calgary, Alberta.: Arctec Canada Ltd. 1 vol. (Canada. Ministry of Transport no. TP 2556).*

This is a study and digest of the Ice Rules of the world's shipping classification societies (eleven in all) governing Ice Class propellers and propeller shafting. Full scale ice torque data has also been examined. Conclusions are drawn from the study, an outline for more comprehensive Arctic regulations given, and recommendations on further work are made.

Available from: TDC Library, Montreal (Interlibrary loan)

08 0310

"Norman McLeod Rogers": icebreaker with diesel-electric and gas turbine-electric propulsion. *(1970). Shipping World and Shipbuilder 163 (January): 175 +*

Available from: See Introduction "Availability of documents" Item (b)

08 0311

Nuclear power advised in icebreaker. *Globe & Mail. Report on Business 22 December 1977: B12.*

Available from: See Introduction "Availability of documents" Item (c)

08 0312

Phinney, J.M. (1971). **Reverse reduction marine drives for high powered gas turbines**. *ASME paper no. 71-GT-82 for American Society of Mechanical Engineers meeting Mar. 28 - April, 1971. 7 pp.*

Recent requirements for marine propulsion gearing have dictated the analysis of and designs for reversing reduction drives with very high power levels, utilizing aircraft type gas turbines as prime movers. Service in either high speed cargo vessels or ships operating in ice bound waters is contemplated. Individual design features of the drive assemblies as well as methods of control and response to transient conditions is explored.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (a)

08 0313

Propulsion systems studied for icebreaking LNG ships. *Globe & Mail. Report on Business 2 March 1978: B12.*

Available from: See Introduction "Availability of documents" Item (c)

08 0314

Rains, Dean A. (1975). **Prospects in naval gas turbine power plant machinery.** *Naval Engineers Journal 87(2): 126-138.*

Prospects for improved gas turbine naval power plant technology that will be available to meet future ship needs are described. New high performance gas turbine engines, machinery maintenance monitoring techniques, improved propulsors such as high skew propellers, waterjets, and pumpjets, advanced speed control and speed reduction devices, combined cycle plants (gas/steam), new fuels, improved anti-icing techniques, and superconducting electric drive machinery are discussed.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

08 0315

Sasaki, H. and S. Yabuki. (1979). **Ice navigation and shafting strength of icebreaker FUJI.** *Marine Engineering Society in Japan. Bulletin 7(1): 87.*

This paper discusses the ice-navigation and studies the strength of propeller blade and propeller shaft of the ice-breaker "FUJI" in ice. The ship has been working for the support of Antarctic research expedition since her completion in 1965.

Acknowledgement: NSFI
Available from: NSFI: cite no. 17913

08 0316

Schaff, J.C., C.W. Connell and J.S. Hollett. (1974). **Nuclear power for offshore Arctic oil exploration.** *In Offshore Technology Conference, 6th, Houston, Texas, May 6-8, 1974 vol. 2, pp. 107-120. Paper no. 2045. Dallas, Texas: Offshore Technology Conference, c/o David L. Riley.*

This paper addresses the problems of pursuing the search for oil in perhaps the most costly and hostile region yet considered for offshore exploration, the offshore Arctic. The total task force for these operations and the feasibility of using nuclear power in the support ships are discussed. Nuclear power is shown to have an early economic advantage over fossil-powered ships even though the nuclear plant develops only 40,000 HP, one-third that normally considered cost effective for marine use.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Items (a) and (b)

08 0317

Servetnik, A. (1967). Povorotnaia napravliaiushchaia nasadka dlia plavaniia v ledovykh usloviiakh. **[Turntable guiding device of ship propellers for ice navigation.]** *Morskoi flot, Feb. 1967 No. 2: p. 32. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

08 0318

75,000 nuclear horsepower prolongs Arctic navigation. *(1978). Marine Week 5(10 March): 12-13.*

Available from: See Introduction "Availability of documents" Item (b)

08 0319

Vassilopoulos, L. and F.M. Hamilton. (1980). **Longitudinal stiffness analyses for the propulsion shafting systems of the Polar Class icebreakers.** *Naval Engineers Journal 82(2): 179-195.*

During the first and second seasons of its deployment in the Antarctic region, the new United States Cost Guard Icebreaker, POLAR STAR, experienced longitudinal vibration problems in the center and wing shaft systems while breaking ice. To minimize and hopefully eliminate the vibratory responses, the USCG initiated several investigations, some of which will be treated in this paper. One of the items under study concerned the axial stiffness of the shafting systems that is contributed by the thrust bearings, their housings and the foundations on which they rest. Aside from model test studies, numerical assessments were made of these stiffnesses using finite element methods and other techniques. In all, three sets of thrust bearing foundations were analyzed in great detail. These include the original (as-built) foundations, a modified configuration that was subsequently adopted for the wing shafts of the POLAR STAR and POLAR SEA, and a reinforced configuration that represents an upper bound on the foundation stiffness that can be achieved without drastic changes in shafting system architecture. The bulk of the paper deals with the development of the three finite element models that were exercised with the NASTRAN Computer Program to predict the stiffness of the three foundation designs. Various considerations that arise in model formulation are treated in some detail, especially the influence of chosen boundary conditions on the final answers. A simplified procedure is next outlined and used for estimating the stiffness of the thrust bearing itself. The estimate is based upon the use of simple structural models whose flexibilities are summed to get the net system flexibility. The results of all the calculations are reviewed in light of the broader objectives of the overall program and recommendations are given for further investigations that will aid in the understanding of the Icebreaker vibration problems.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (b)

08 0320

Verevkin, V.F. (1976). Osobennosti vybora silovykh ustanovok ledokolov i sudov ledovogo plavaniia dlia Dal'nevostochnogo basseina. **[Selecting propulsion means for icebreakers and ice navigation ships in the Far Eastern Basin.]** *Vladivostok. Dal'nevostochnyi nauchno-issledovatel'skii gidrometeorologicheskii institut. Trudy, 1976 Vol. 62: p. 184-185. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

08 0321

Vikhrov, V. (1976). Modernizatsiia grebnoi elektricheskoi ustanovki atomokhoda "Lenin". **[Modernization of the electric propulsion plant of the atomic icebreaker "Lenin".]** *Morskoi flot, 1976 No. 2: p. 48-49. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

08 0322

YPASS: a new propulsion system for icebreakers. *(1980). Marine Engineers Review (February): 19.*

A totally new form of propulsion for ice covered waters, the YPASS, may reduce the possibility of damage by ice and also provide 50% more propulsion force. The propellers and rudders are inside a Y-shaped duct within the ship's hull which restricts the size of ice that can enter the system thereby reducing the ice impact forces to manageable proportions. The YPASS configuration also permits maintenance and repair to be performed at sea by closing the butterfly valves. An interesting feature is that YPASS can be retrofitted on existing ships as an additional structure, without disturbing the existing drive arrangements and engine-room layout. Further optimization tests were due in 1980. (FT)

Acknowledgement: Oceanic Abstracts

Available from: See Introduction "Availability of documents" Item (b)

08 0323

Zakharov, IU.P. (1967). Puti povysheniia effektivnosti raboty grebnykh elektricheskikh ustanovok ledokolov. ***[Ways of improving the performance of propelling units in icebreakers.]*** *Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota, Trudy, 1967 Vol. 76: p. 57-66. (in Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

08 0730

ASEA. (1978). **Study of propulsion system of LNG tankers, at 130 MW.**

Available from: Petro-Canada: cite no. 284

09 Research Facilities, Policies and Programs

09 0324

Bates, C.C. (1973). **Navigation of ice-covered waters: some new initiatives by the United States of America**. *In International Congress of Navigation, 23rd, Report, Section II, Subject 4, pp. 139-164. Brussels, Belgium: Permanent International Association of Navigation Congresses, 1973.*

Available from: TC Library, Ottawa (Interlibrary loan)

09 0325

Canada: (Offshore operations review). *(1979). Ocean Industry 14(4): 341-345.*

Ice technology developments and frontier areas are emphasized. Canadian Marine Drilling Ltd. (CANMAR) put together a fleet-composed of 3 specially designed drillships, 7 supply ships (4 also Arctic Class II icebreakers), and 1 seafloor dredging barge and increased the 1978 drilling period in the Beaufort Sea to = 110 d. CANMAR has a $30 million Arctic Class IV icebreaker-supply ship under construction and hopes to extend further the number of drilling days. CANMAR is designing second-generation drillships, equipped with a turret mooring system, to use for year-round exploration. Other topics reviewed include the 1st Arctic subsea completion-achieved in Drake Field; a project proposed to ship LNG by icebreaker tankers; a Canadian-designed and manufactured 1 atm subsea production system which went into operation in Feb. off Brazil; a charter for use of the manned commercial submersible, Auguste Picarde; and various unmanned submersible orders, including the new Dart. (FT)

Acknowledgement: Ocean Abstracts
Available from: See Introduction "Availability of documents" Item (b)

09 0326

Cohen, M. (1970). **The Arctic and the national interest**. *International Journal 26(1): 52-81.*

Available from: See Introduction "Availability of documents" Item (b)

09 0327

Cottrill, Adrian. (1979). **Breaking ice for Arctic oil**. *Offshore Engineer 1979 (12): 40-52.*

The world's most exciting new frontier region is entering a critical phase. When Canada's Dome Petroleum announced its first potentially commercial oil strike in the Beaufort Sea, many will have asked the question; "now they have found it, how will they possibly exploit it?" Our international editor Adrian Cottrill has been to find the answer and discovered that the company already has some fairly clear ideas. He talked with senior Dome engineers in their Calgary Offices, and during a four-day visit to the North, overnighted on a drillship and at Tuk base, to sample the realities facing operations there. His review of Dome R and D looks in particular at how Dome is tackling its two chief challenges: evolving an oil production and transportation system for this unique area; and extending the season for the world's most costly drilling operations. (Author).

Acknowledgeemnt: ASTIS
Available from: See Introduction "Availability of documents" Item (b)

09 0328

Crosby, R.L. (1977). **Ice engineering research at CRREL**. *Arctic Bulletin 2(10): 177-182.*

Available from: See Introduction "Availability of documents" Item (b)

09 0329

*Demina, G.M. (1969). Nekotorye voprosy vosproizvodstva ledokol'nogo flota. [***Development of the Russian icebreaker fleet.***] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1969 Vol. 105: p. 127-132. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

09 0330

Development of Arctic sea transportation. *(1970). Marine Technology Society Journal 4(5): 17-68.*

Available from: See Introduction "Availability of documents" Item (b)

09 0331

Edwards, R.Y. (1970). **Engineering research in support of development of Arctic sea transportation**. *Marine Technology Society Journal 4(5): 44-59, 64-68.*

The research which the Coast Guard has undertaken to develop and refine techniques for the design of marine surface vehicles for operation in ice covered waters is described. In the area of resistance and powering predictions, the topics discussed are modes of motion in ice, mechanics of icebreaking, ramming experiments and analysis, and model tests. In the area of propulsion system design, the topics discussed are propeller ice interactions, propulsion system dynamics, controllable pitch propellers, and triple screw installations.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

09 0332

Edwards, R.Y., Jr. (1973). **Cold region marine technology: current contributions and future challenges**. *Naval Engineers Journal 85 (August 1973): 35-52.*

Available from: See Introduction "Availability of documents" Item (b)

09 0333

Edwards, R.Y. et al. (1979). **Development of a research program for improving Arctic marine transportation technology**. *Kanata, Ontario: Arctec Canada Limited. 3 vols.*

Presented in this report is a Research Program and Full Scale Demonstration Program designed to establish in Canada, the capability to perform Arctic surface marine operations with confidence for any reasonable purpose on an all-season basis.

This volume is one of three. It contains a condensation of the detailed status reports for four categories of Arctic marine system performance (Ice Transmitting, Hull Structural Integrity, Propulsion System and Appendage Performance and Collision and Hazard Avoidance). Also contained in this volume are cost estimates, schedules and plans for

16 research and development programs and one full scale demonstration program with a Canadian built high Arctic class 95,000 ton combination ore/oil carrier.

Volume II contains four discussions of the state-of-the-art of ice transmitting performance, hull structural integrity, propulsion system and appendage performance and collision and hazard avoidance. In volume I we have included sufficient material which was extracted from Volume II to provide a causal relationship between Research and Development requirements and the effectiveness of the state-of-the-art.

Volume III is a bibliography for this study.

A brief summary, under separate cover, contains a condensation of Volume I of this study.

Available from: TDC Library, Montreal (Interlibrary loan)

09 0334

Fifty million dollar ice operations center will develop Arctic. *(1979). Marine Engineering/Log 84(2): 19.*

A $50 million "cold water" and ice-breaking vessel research center will be completed by the early 1980s at Memorial University, St. John's, Newfoundland. Established under the auspices of the Canadian National Research Council, the research center will help develop Canada's Arctic, and it will be of particular importance to this Atlantic Canadian province where offshore oil and commercial fishing activities are expected to increase considerably over the next five years. The center will carry out an intensive effort to improve the design of ice-breaking craft and offshore oil structures to assure their safe and efficient operation in the cold waters off Newfoundland and Labrador. The facility will include a "world class" ship dynamics laboratory; extensive ice tank and open water tank vessel testing facilities; and an installation to fabricate automated ship models. Ship and offshore model facilities will include a 16 x 80 meter ice tank to be completed in 1981, and 16 x 120 meter open water tank. (No further information in article.)

Acknowledgement: MRIS

Available from: TC Library, Ottawa (Photocopying service)

09 0335

Harrison, G.R. (1979). **The need for action-oriented R and D in the Canadian Arctic**. *In Proceedings of the Symposium of Marine Transportation and High Arctic Development: Policy Framework and Priorities, Montebello, Quebec, March 21-23, 1979, pp. 45-58. Ottawa: Canadian Arctic Resources Committee.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

09 0336

Harrison, G.R. (1981). **Implications to Canada of Arctic marine technology**. *Presented at the Annual Meeting of the Canadian Shipbuilding and Ship Repairing Association, Montreal, Quebec, February 10, 1981.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

09 0337

Kierans, T.W. and P.J. Amaria. (1975). **Proposed formulation and analysis procedure for a national policy on Canadian ice-capable ocean transport management**. *NATO conference series: II, Systems science, Conference on Arctic systems. St. John's, Newfoundland, August 1975. Proceedings, 1977 Vol. 2, p. 513-552.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

09 0338

Marine transportation and High Arctic development: policy framework and priorities, Montebello, Canada, March 21-23, 1979. Proceedings. *Ottawa, Ont.: Canadian Arctic Resources Committee, 1979.*

Complete proceedings are presented considering the most important and immediate problems needed to be solved in order to develop marine transportation in the Arctic in the national interest of Canada. Means of solving these problems are discussed. Areas of discussion include basic and applied science, the socio-economic problems involved, the regulatory problems, and the legal and international aspects. More specifically, ship transport in ice conditions (i.e., environmental aspects), exploitation of marine resources and their transportation needs (e.g., petroleum), the Canadian security policy, research and development, a general overview of marine activities, and the USSR capabilities in Arctic marine transport are examined. (FT)

Acknowledgement: Oceanic Abstracts

Available from: TC Library, Ottawa (Interlibrary loan)

09 0339

O'Rourke, J. Cameron. (1979). **Canada's research and development imperatives — ice covered waters**. *In Proceedings of the International Hydrographic Technical Conference, 1st, Ottawa, May 14-18, 1979, pp. 183-236. Ottawa: Canadian Institute of Surveying.*

This paper describes Arctic Research and Development if Canada is to construct and operate the Arctic marine systems necessary if oil and gas is to be exploited in the Beaufort Sea and other Arctic regions within the next ten years. R & D must be intensified in five specific areas: 1. To determine optimum design characteristics and performance expectations for large ice-breaker vessels under the full range of possible ice conditions that can exist throughout the Canadian Arctic; 2. To develop techniques which give high resolution measurement of ice properties and conditions from earth satellites in all weather and in darkness; 3. To develop new concepts and practical field methods to break up high strength ice forms such as ice ridges, multi-year ice floes, and ice islands; 4. To obtain improved understanding on the effect of oil in Arctic waters; 5. To develop improved concepts and systems to clean up oil in ice-covered waters. A broad spectrum of new technology will be developed peculiar not only to Canada's Arctic needs but to the needs of all polar development. (Author).

Acknowledgement: ASTIS

Available from: See Introduction "Availability of documents" Items (a) and (b)

09 0340

Pioneer ice tank for ship research. *Financial Post 21 October 1978: 11.*

Available from: See Introduction "Availability of documents" Item (c)

09 0341

Smith, J.G. (1970). **Logistics operations APOA Beaufort Sea projects 1970**. *Calgary, Alta.: Arctic Petroleum Operators Association. Report, 1970-APOA 2-3. 75 pp.*

Available from: APOA

Price: $43.50 (photocopy) $8.50 (microfiche)

09 0342

Steady progress in Arctic shipping. *(1979). Motor Ship Vol. 60 (July 1979): 31.*

The article outlines some of the activities and proposals of various countries, particularly those of Canada, in developing icebreakers and icebreaking cargoships for use in the exploitation of the natural resources of the Arctic, and briefly describes a Gotaverken design for an Arctic bulk-carrier and a design from Shipping Research Services (the

Norwegian consultants) for an offshore supply vessel for Arctic operation. The bulk-carrier design is for a 37,000-dwt vessel, with twin-screw 76,000-shp steam-turbine propulsion, which would be built to Canadian Arctic Class 10 standards for all-the-year-round operation. The supply ship, which would be capable of anchor-handling and towing, is a 2,400-dwt single-screw two-engine (2 x 4,770 bhp) design which incorporates a shelter-deck. General-arrangement drawings are included of these two designs.

Available from: TC Library, Ottawa (Photocopying service)

09 0343

Voelker, R.P. (1977). **Research plan for Arctic ship powering and development.** *Columbia, Md.: ARCTEC Inc. Final report. Report no. 416C-3. 58 pp.*

This study examines and documents the basis for an Arctic surface ship transportation system and identifies the major elements of a research program designed to upgrade the state-of-the-art of Arctic marine transportation technology in order to minimize its risk and improve its attractiveness as a viable alternative to other modes of transportation.

Acknowledgement: NTIS

Available from: NTIS: cite PB-285871/0ST

09 0344

Walter, -. (1979). **Research and development activities relating to large icebreaking ships.** *Schiff und Hafen 31(September): 752. (In German.)*

Brief information is given on AG Weser's various research and development activities concerning icebreaking ships and their operation. These activities, most of which have been partly supported by the West German Government, include: the EOS project (the icebreaking OBO-carrier studies) which embraced the many important problems concerning Arctic ship-operations; the EOS routing study, in which AG Weser functioned as general managers for an expedition of 25 scientists to the Canadian Arctic, in 1972, to investigate the properties of sea ice; model tests in the HSVA ice-tank to establish model/ship correlation; the EOS extension (in 1973-76) to propulsion, plants and transmissions and to submerged-arc welding of low-temperature resistant steels; EOS A — model tests, in 1978, on unconventional forebody forms; EOS B — optimisation of the ship together with its propulsion arrangements; EOS C — risk analysis of a triple-screw LNG tanker (studied in EOS B) operating, all the year round, between the USA and the Arctic; the specification, for the West German ministry concerned, of a research and supply ship for the Antarctic; and the possible building of two icebreaking LNG tankers for the Canadian Government's Melville Island project.

Acknowledgement: BSRA

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

09 0688

Keinonen, A. (1978). **Presentation of sea-ice ridges in general and physical characteristics of Baltic ridges for ship resistance calculations.** *University of Helsinki, Institute of Marine Research, Winter Navigation Research Board. Research report no. 24. 31 pp.*

Acknowledgement: OEIC

Available from: OEIC: cite no. EO5527

09 0731

Dome Petroleum Ltd. (1978). **Arctic marine research and study program.** *Calgary: Dome Petroleum.*

Available from: Petro Canada: cite no. 164 See also Introduction "Availability of documents" item (a)

09 0732

Dome Petroleum Ltd. (1980). **Research program for the Canmar Kigoriak: An experimental Arctic Class 4 Icebreaker.** *Calgary: Dome Petroleum.*

Available from: Petro-Canada: cite no. 393 See also Introduction "Availability of documents" item (a)

09 0733

Canada. Transport Canada — Marine. (1980). **International technological developments in the field of marine transportation.**

Available from: Petro-Canada: cite no. 434

10 Ship Trials — Performance

10 0345

Allan, R.J. (1977). **Results of full-scale trials in ice to further assess the icebreaking capability of the CCGS Wolfe.** *Kanata, Ontario: Arctec Canada Ltd. 32 pp.*

Available from: TDC Library, Montreal (Interlibrary loan)

10 0346

ARCTEC Inc. (1973). **Full scale tests of Great Lakes Bulk Carrier LEON FRASER in ice fields 1972-73: parts 1-3.** *Columbia, Md.: ARCTEC. 233 pp.*

Acknowledgement: NTIS
Available from: NTIS: Cite no. COM-10933-SET
Price: $16.50 U.S.

10 0347

Arctic Systems Limited. (1977). **Adaptation, operation, testing and evaluation of Arctic Systems Limited ACV Iceater I for icebreaking trials in conjunction with commercial vessels and CCGS Alexander Henry (Griffon) during the winter 1976-77: phase II.** *Ottawa, Ont.: Arctic Systems Ltd.*

This report presents the results of full-scale testing of the Arctic Systems LTD (ASL) air cushion craft ICEATER I on Thunder Bay, Ontario, during the winter of 1976/1977. The primary purpose of these tests was to continue the systematic examination of the icebreaking effectiveness of an ACV craft when used with a broader spectrum of commercial type ships. A secondary purpose was to continue the technical investigation of this icebreaking phenomenon and add to the existing body of data, so that an understanding of the mechanisms involved might be enhanced.

Available from: TDC Library, Montreal (Interlibrary loan)

10 0348

Ball, M.A. (1977). **Report of the full-scale icebreaking tests of an air cushion bow platform attached to CCGS Alexander Henry, Thunder Bay, Ont., January-April 1976.** *Ottawa: Canadian Coast Guard, Air Cushion Vehicle Division.*

Available for consultation only at TDC Library, Montreal

10 0349

Basargin, V. (1967). Praktika ekspluatatsii teplokhodov tipa "Baltiiskii" v ledovykh usloviiakh. **[Performance of "Baltiiskii" diesel ships under ice conditions.]** *Rechnoi transport, 1967 26(11): p. 48. (In russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

10 0350

Benze, D.L., T.V. Kotras and R.Y. Edwards. (1972). **Analysis of the icebreaking performance of the Ministry of Transport St. Lawrence River/Arctic icebreaker.** *[S.l.] Arctec Inc. final report no. 0094.*

Available from: TC Library, Ottawa (Interlibrary loan)

10 0351

Bradford, J.D. (1978). **Icebreaking capability of CCGS "Labrador" in western Barrow Strait, October 23-28, 1973.** *Ottawa: Dept. of Fisheries and the Environment. (Manuscript report series. Canada. Marine Sciences Directorate, no. 50). 12 pp.*

The icebreaker CCGS "Labrador" journeyed to western Barrow Strait in late October, 1973 to undergo performance trials. While suitable ice conditions for the test were being sought, vessel progress through 320 miles of pack ice was monitored... enough resistance was encountered to suggest that in normal years, vessels with the "Labrador's" icebreaking capability would be unable to operate in Barrow Strait beyond mid-November. (Author).

Acknowledgement: ASTIS
Available from: TC Library, Ottawa (Interlibrary loan)

10 0352

Bradford, J.D. (1979). **Icebreaker probes to Lake Melville, Labrador, in 1972.** *Ottawa: Dept. of Fisheries and Oceans, Scientific Information and Publications Branch. Manuscript report series — Canada. Marine Sciences Directorate, no. 54. 40 pp.*

This report is an account of two probes undertaken in January and April, 1972. It includes hourly observations of ice conditions and power output. The January probe succeeded in reaching the west end of Lake Melville, but difficult ice conditions were encountered in Labrador coastal pack ice off the eastern end of the Strait of Belle Isle and in hummocked fast ice at the east end of Lake Melville. The April probe failed to reach Lake Melville being stopped by heavy Labrador pack ice northeast of Cartwright, Labrador. As in the January probe, difficult ice conditions were also encountered off the eastern end of the Strait of Belle Isle. (Author).

Acknowledgement: ASTIS
Available from: TC Library, Ottawa (Interlibrary loan)

10 0353

Brix, J.E. (1978). **On the problem of manoeuvering-characteristics in ice.** *Schiff und Hafen 30(April): 4 pp. (In German.)*

This paper, presented in Hamburg, in Nov. 1977, is part of the 12th Progress Report of the AGSV (the German "Study Group of the Ship Experimental Establishment"). The Author, of the HSVA, gives an account of an investigation carried out to provide initial information on the relationship between a ship's manoeuvring characteristics in ice-free water and those in ice, and on the relevant factors of influence. The investigation included full-scale tests off Spirzbergen, in homogeneous fast ice, with the 1976-built ice-strengthened supply-ship/tug Werdertor, which has twin ducted propellers and twin spade rudders; propulsion power is 2 x 3,478 kW, and a transverse thruster of 7 tonnes static thrust is installed; length b.p. is 61.8 m. The tests in ice were confined to turning manoeuvres; shipboard Decca radar was used in measuring turning-circle diameter. The tests, including the techniques used, are described, and the turning-cycle equations and the results of the tests in ice, together with those in ice-free water, are presented and discussed in detail.

Acknowledgement: BSRA
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

10 0354

Buck, J. and C.W. Pritchett. (1978). **Air cushion vehicle (ACV) icebreaker test and evaluation program: Volume I; executive summary.** *Washington, D.C.: U.S. Coast Guard Research and Development Centre. Report no. CGR/DC-12/78. 39 pp.*

During the winter ice season, November 1977 through March 1978, the U.S. Coast Guard R&D Center, Avery Point, Connecticut, conducted an operational test program to evaluate air cushion vehicles as icebreakers. The vehicles used were the MACKACE ACV barge and the self-propelled LACV-30. Tests were conducted on the Illinois and Mississippi Rivers with operations centered around Peoria, Illinois. The MACKACE ACV was used solely to facilitate river commerce while the LACV-30 was used in this role and also for flood control purposes. Extensive operational tests were conducted which produced data concerning icebreaking techniques and the effects of icebreaking on river commerce. Tests also established information on design criteria for ACV icebreakers, their maneuverabilty and control, operating costs and impact on Coast Guard personnel and facilities. As a result of the test program, significant advances were made in understanding ACV icebreaking procedures. The characteristics of ice were studied, and the necessity for developing ice classification and an icebreaking effectiveness methodology was identified. (Author).

Acknowledgement: NTIS
Available from: NTIS: cite AD-A077 291/3
Price: $6.00 U.S.

10 0355

Canada. Coast Guard. (1975). Canadian coast guard ACV evaluation and development unit report on winter and icebreaking evaluation of CCG Voyageur CH-CGA. *Montreal, Quebec: Coast Guard. 20 pp.*

Available from: TDC Library, Montreal (Interlibrary loan)

10 0356

Dickins, D.F. (1974). **Ice conditions Canadian Coast Guard Voyageur icebreaking trials Parry Sound, Ontario, February 5-19, 1974.** *Ottawa, 1974. Unpublished manuscript prepared for the Canadian Ministry of Transport, Air Cushion Vehicle Division. 37 pp.*

Available from: TC Library, Ottawa (Interlibrary loan)

10 0357

Drazin, Donald H. (1980). **Machinery and ship tracking data for ice-breaking trials conducted on U.S. coast guard cutter KATMAI BAY (WTGB-101).** *Bethesda, Md.: David W. Taylor Naval Ship Research and Development Center. Final report Jan. - Mar. 79. Report no. DTNS RDC-80/024. 710 pp.*

This report contains the results of ice-breaking trials conducted on the United States Coast Guard Cutter KATMAI BAY (WTGB-101) during January-March 1979. Data include: powering, speed, and machinery measurement obtained while operating in level and brash ice in the vicinity of Sault Sainte Marie, Michigan. The various types of trial runs conducted included: (1) continuous, level ice-breaking; (2) ice-breaking in brash ice; (3) ice-breaking by ramming; (4) maneuvering in level and brash ice; (5) rudder torque validation; and (6) bollard pull. The data are presented in graphical and tabular form. No attempt is made to analyze the data as it is understood that these data will be included in a comprehensive overall report to be published by the Coast Guard Research and Development Center.

Acknowledgement: NTIS
Available from: NTIS: cite AD-A082 373/2 (microfiche only)
Price: $3.50 U.S.

10 0358

Dunne, M. (1978). **Results of tests conducted using ships of two different breadths to push an air cushion transporter in ice.** *Kanata, Ontario: Arctec Canada Ltd. 30 pp.*

Icebreaking tests were conducted in Thunder Bay Harbour, February 19, March 27-30 and April 13, 1977, using the air cushion icebreaker "ICEATER I", the CCGC GRIFFON, and the tanker IMPERIAL ST. CLAIR. Unscheduled events prevented the complete test program from being carried out, but a limited amount of data was gathered. At full power, the CCGC GRIFFON/ICEATER I combination was able to continuously proceed through an 81 cm ice cover (with high E modulus) at approximately 7 knots. When the E modulus decreased, as in the March tests, speed was 1.6 knots in 75 cm ice. The IMPERIAL ST. CLAIR/ICEATER I combination was unable to proceed continuously through the 81 cm ice cover, nor was it able to turn under these conditions.

In March, ramming tests were conducted in 75 cm ice cover (no snow) with the ST. CLAIR, both alone and with the ICEATER on the bow. The hovercraft produced no discernable positive or negative effect.

Propeller-ice interaction was monitored on the GRIFFON in the March and April tests, and the results indicate no significant ice induced torques in the deteriorating ice, and no differences regardless of whether the ICEATER was on the bow or the ship was operating alone.

Pressure measurments conducted as the GRIFFON/ICEATER combination passed by the wharf, showed no unusual effects. The only detectable pressure change was caused by the wake of the GRIFFON.

Total shaft horsepower of the GRIFFON is 4,250 HP, while that of the IMPERIAL ST. CLAIR is 6,000 HP. The beams of the vessels are: GRIFFON, 15 cm; IMPERIAL ST. CLAIR, 23 m; ICEATER I, 17.5 m. For these tests, ICEATER I was operating at its heaviest weight, 304 tons, giving a cushion pressure of 85 cm. (Author)

Available from: TDC Library, Montreal (Interlibrary loan)

10 0359

Dutfield, D.O. and D.F. Dickins. (1974). **Icebreaking trials with the Bell Aerospace Voyageur ACV.** *Canadian Aeronautics and Space Journal 20(10): 471-474.*

Available from: See Introduction "Availability of documents" Item (b)

10 0360

Edwards, R.Y. et al. (1979). **Results of trials in ice and open water of CCGS Pierre Radisson.** *Kanata, Ont.: Arctec Canada Ltd. 4 vols.*

Available from: TDC Library, Montreal (Interlibrary loan)

10 0361

Edwards, R.Y., R.J. Allan and M.A. Dunne. (1976). **Results of full scale trials in ice of the CCGS Wolfe: volume 1, revised 31 December 1976.** *Montreal, Quebec: Arctec Canada Ltd. 66 leaves. Photocopy of typescript.*

Full scale trials were conducted in ice covered waters on the CCGS WOLFE during the winter of 1976 after fitting of a newly designed bow in order to assess the vessel's performance in various modes of operating in ice and to compare its performance with that observed in trials previous to the installation of the new bow form.

The main motivation for the comparative testing described in this report was to establish with full scale results, whether the new low angle bow was superior to the bow type heretofore used on Canadian icebreakers and to conventional bow shapes such as that used in the LABRADOR or WIND CLASS Icebreakers. This new bow form is now incorporated into the now building "R" Class icebreaker and is also to some extent factored into the design of the POLAR VII.

Twenty-eight continuous mode and ramming mode icebreaking tests were conducted in the Gulf of St. Lawrence area during February and March 1976 on the CCGS WOLFE. The ice conditions were extremely unfavourable. Very little variation in ice thickness was obtained due to the single short period allowed for tests. Later in the Spring, tow rope pull trials were conducted on that ship to provide a tool for estimating the thrust available for icebreaking using observations of ship speed, propeller speed and shaft torque.

The full scale data covered a very limited range of ice thicknesses and ice strengths.

The full scale data from the tests of the "new" WOLFE were analyzed in their raw form and in a dimensionless form. The results of the tests of the "new" WOLFE were compared with test results on the "old" WOLFE which were acquired in 1969 and with similar test results accumulated on U.S.C.G.C. STATEN ISLAND in 1969 in the Bearing Sea. (Author modified) (DS)

Available from: TDC Library, Montreal (Interlibrary loan)

10 0362

Edwards, R.Y., Jr., J.P. Nadreau and M.A. Dunne. (1976). **Results of full scale field trials of ACT-100 with CCGS Alexander Henry**. *Montreal, Quebec: Arctec Canada Ltd.*

A series of comparative full scale trials on an icebreaker (CCGS ALEXANDER HENRY) and air cushion platform (ACT-100) were conducted by the Department of Transport in Thunder Bay during the winter 1975-76. Among the objectives of the trials was the determination of the relative icebreaking performance of an icebreaker and that same icebreaker pushing an air cushion platform intimately connected to its hull.

The approach used to measure full scale relative performance was to determine power, speed and ice characteristics and then to compare ship speed versus ice thickness for the candidates at total constant installed power.

The propulsion thrust of CCGS HENRY was measured as well as shaft horsepower to permit comparison of the resistance to motion in ice of the two "test vehicles" with other full scale icebreaking test results.

Twenty-nine tests were conducted wherein the CCGS ALEXANDER HENRY connected to ACT-100 travelled through level ice fields ranging in thickness from 12 to 30 inches (30 to 76 cm) at essentially constant speeds ranging from 1.3 to 14.6 ft/sec (0.4 to 4.45 m/sec). Five similar tests were conducted without the ACT-100 attatched to CCGS ALEXANDER HENRY. These were conducted in essentially one level ice thickness of 9-11 inches (23-28 cm) at speeds ranging from 2.7 to 6.0 ft/sec (.82 to 1.83 m/sec).

The mean flexural strength of the ice varied between 66 and 126 lbs/in^2. The depth of snow cover varied between zero and 15 inches (0 to 38 cm). Open water resistance tests were conducted as well.

The data from the trials in ice were subjected to regression analysis mainly to obtain mathematical expressions for the thrust required to propel the ship alone and the ship plus the ACT-100 in terms of speed and ice characteristics in order to simplify the comparison of the two "test vehicles" with one another and with other previously tested ships. The results of the tests are summarized. (Author modified) (DS)

Available from: TDC Library, Montreal (Interlibrary loan)

10 0363

German, J.G. and R.G.A. Lawrence. (1975). **Full scale testing in ice of three icebreakers**. *In Proceedings of the Ice Tech Symposium, Montreal, Canada, April 9-11, 1975, pp. H1-H37. New York, N.Y.: Society of Naval Architects and Marine Engineers, 1975.*

In 1967 the Canadian Coast Guard commenced to use modeling techniques in the development and planning of new icebreakers. It was apparent that model testing and production techniques for full scale performance in ice, unlike open water techniques, was seriously lacking in actual full scale performance data for confirmation and correlation. Accordingly the Coast Guard undertook some full scale testing programs as time and expediency permitted. Three such testing programs are reported on in this paper, starting with CCGS WOLFE in 1969, LOUIS ST-LAURENT in 1970 and LABRADOR in 1973. Up to now the results have not been published. The results of full scale measured tests in ice are still woefully lacking and it is the purpose of this paper to help fill the gap by publishing these results. Having occurred over a span of several years and taken place for different purposes in widely different conditions, the test techniques and formats are not the same for the three sets of tests. The results presented are "raw", as developed at the time of the tests and have not been reworked.

Acknowledgement: SNAME
Available from: SNAME

10 0364

German, J.G. et al. (1980). **M.V. "Arctic" scientific evaluation project: data collection activity, 1979-80 season**. *Montreal, Quebec: German & Milne Inc. 2 vols.*

This is a report in 2 volumes on the data collecting activities carried out by the staff of German & Milne Inc. on-board the M.V. "Arctic" during the 1979 navigational season. Volume 1 of the report includes a narrative of events, photographs, sampling patterns, recording location maps, recommendations and conclusions. This report also provides a program listing, statistical output and limited data analysis, and video tape records. Data collection covered in this report was carried out in the semi-automatic mode for most of the ship operating season in the Arctic.

Volume 2 of the report covers the data collection carried out during a set of dedicated full scale ice trials held on the Saguenay River in January 1980. Data reduction and some analysis of these trials are also provided.

Available from: TDC Library, Montreal (Interlibrary loan)

10 0365

German, J.G. et al. (1980). **M.V. "Arctic" scientific evaluation project: data collection activity, 1979-80 season: summary report**. *Montreal, Quebec: German & Milne Inc. 22 leaves.*

This report summarizes the data collecting activities carried out by the staff of German & Milne Inc. on-board the M.V. "Arctic" during the 1979 navigational season, and also summarizes the limited analysis work carried out by this contractor following data collection.

A summary is also provided of the data collection carried out during a set of dedicated full scale ice trials held on the Saguenay River in January 1980. Data reduction details and some analysis of these trials are also summarized.

Available from: TDC Library, Montreal (Interlibrary loan)

10 0366

Gill R. (1980). **Franklin probes Lake Melville**. *C-CORE News 5(2): 5-6.*

This article describes the field trials of the CCGS Franklin conducted on Lake Melville in January. The primary objective was navigating through heavy ice ridges on the lake and thereby demonstrating that the season for routine operations could be extended through the winter. The probe was considered to be wholly successful.

Acknowledgement: Arctic Institute of North America
Available from: CISTI (Photocopying service)

10 0367

Hearnshaw, Douglas. (1980). **The M.V. "Arctic" performance evaluation program**. *Unpublished preprint. Presented to the Third Annual CMTA Marine Planning Conference, Ottawa, April 30th, 1980.*

Available from: TDC Library, Montreal (Interlibrary loan)

10 0368

Ivanin, Y. (1978). **Soviet A-power conquers North Pole.** *Canadian Shipping and Marine Engineering 49(6): 26-29.*

In August 1977 the USSR atomic powered icebreaker Arktika made the round trip from Murmansk to the North Pole in 13 d. Patterned after the 1st Russian atomic icebreaker Lenin, the Arktika incorporates many of the latest Soviet accomplishments in science and technology. Principal particulars include: overall length, 148 m; beam, 30 m; draft, 11 m; and maximum speed, 21 kn. The 75,000-hp vessel rotates 3 propellers, each spanning a diameter of 5.7 m. Almost half of the voyage was spent in maneuvering through unbroken icefields. Details of the voyage are discussed. Classic icebreaking patterns were followed; however, when needed, the Arktika could ram through 4-m thick blocks of ice. On several occasions the ship employed a special system for fore and aft trimming and heeling to free itself from ice blockages. Emergency provisions included a 7-mo food supply, extra helicopter, bulldozer, dragharrow to build a landing strip on ice,explosives, building materials, and spare parts. The expedition was conducted to test the icebreaker and to confirm the economic feasibility of such journeys. Nuclear fuel is probably the most advantageous fuel for ships designed to operate in the Arctic. Using atomic icebreakers has nearly doubled the navigational season along the northern sea route and has reduced time at sea. In Feb. 1978 the USSR launched its 3rd nuclear icebreaker Sibir; although similar to the Arktika, its improved systems are more reliable. (FT)

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

10 0369

Lawrence, A. (1979). **Ice-maiden voyage.** *Canadian Shipping and Marine Engineering 50(11): 28-32.*

The Canadian Coast Guard ship Pierre Radisson, an icebreaker, was tested from July 10 to Oct. 28, 1978, in the Arctic Ocean N of Canada. A diesel-electric propulsion system and a low-angle concave bow form with ice knife were important new design features of this vessel. Results of dock and sea trials and of the trial run through the Northwest Passage are described. Some problems with the propulsion system occurred, but were corrected. (FT)

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

10 0370

*Levit, B.M. (1965). Rezul'taty naturnykh i model'nykh ispytanii opytnogo ledokola s "vibratsionnoi" ustanovkoi. [***Results of field tests and modeling the performance of an experimental icebreaker equipped with a vibration producing device.***] Trudy koordinatsionnykh soveshchanii po gidrotekhnike, 1965 No. 17: p. 174-184. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

10 0371

Makinen, E. and R. Roos. (1977). **Ice navigation capabilities of "LUNNI" Class icebreaking tankers.** *Paper presented at the meeting of the Eastern Canadian Section of SNAME in Montreal, November 22, 1977. New York, N.Y.: Society of Naval Architects and Marine Engineers.*

The "Lunni"-Class ships are 16,000-dwt tankers owned and operated by Neste Oy, a Government-owned oil company in Finland. A basic requirement of these ships was that they should be capable of operating in normal ice conditions throughout the Baltic, independently of icebreaker assistance. Following a general description of the ships and their ice-related features, in particular the Wartsila Air Bubbling System (WABS) with which they are fitted, the paper gives an account of trials of one of the ships in ice. These trails were conducted with the second ship of the series, the Sotka, in the Gulf of Finland and the Gulf of Bothnia in severe ice conditions. Test results are presented, demonstrating the efficiency of WABS in maintaining the icebreaking capability of the ship.

Acknowledgement: BSRA
Available from: SNAME

10 0372

Michailidis, M. (1980). **CCGS Franklin icebreaking probes I and II into Lake Melville, Labrador in January and March 1980.** *National Research Council Canada. Division of Mechanical Engineering. Transportation 12(3).*

Available from: CISTI (Photocopying service)

10 0373

Research voyage data brings Arctic drilling nearer. *(1979). Ocean Industry 14(11): 90-92.*

The Federal Republic of Germany Werdertor cruise was designed to collect data on the environmental factors and the physical characteristics of ice in the high north region near Spitzbergen, to determine the ice-breaking characteristics of the ship under various operating and ice conditions, and to determine optimum technique of ice-breaking. Special added equipment included: 5 nozzles on the bow for injecting an air-water mixture designed to lower frictional resistance while underway in the ice, a jet mantle to prohibit obstruction on the propeller, a subsea TV system to monitor ice flow around the ship's hull, and tension strips placed at critical sections on the hull to determine deformation. Significant findings were: the jet system not only cut frictional resistance but also increased the vessel's propulsion by 20%, the jet mantle dispersed even the largest ice blocks from the propeller area, and the ship easily penetrated 80 cm-thick ice fields with speeds at 8.5 kt, and consistently rammed through ice fields $< = 1.3$ m thick, penetrating a vessel's length on each ramming run. (FT)

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

10 0374

Schwarz, J. and L. Hoffman. (1978). **Icebreaker trials around Spitzbergen.** *In Proceedings of the IAHR Symposium on Ice Problems. Lulea, Sweden, August 7-9, 1978, Part 1]. 15 pp. [S.l.]: International. Association for Hydraulic Research.*

Available from: See Introduction "Availability of documents" Item (a)

10 0375

Tronin, V. (1967). Rezul'taty ispytanii upravliaemosti ledokolov. **[Results of tests on icebreaker maneuverability.]** *Rechnoi Transport 26(7): 23. (In Russian.)*

Reports on tests of the Don (1961) and the Terek (1966) model-16 river icebreakers of identical hull and propulsion-steering mechanisms. The Terek is equipped with three rudders: a center fair-form rudder of 5 m^2 area and two secondary semi-balanced rudders of 2.8 m^2 area each. Both steering devices have lower supports, those supporting the secondary rudders are extensions of the propeller non-steering nozzle. When working in ice, and the nozzles became obstructed with crushed ice, they were demounted, along with the secondary rudders. The tests were conducted to determine the maneuverability of icebreakers with and without the secondary rudders. The results given in a graph, show the dependence of the main parameters on stabilized circulation (angular velocity, w, of the ship turning, full-speed running velocity, y, and the circulation radius, R_r) on the rudder angle, a_r. The graph shows that for $a_r < 20°$ the turning quality of a three-rudder icebreaker is considerably inferior to the single rudder action, and that an increase of the rudder area increases the ship turning quality for only $a_r > 20°$. It was

also found that the greater area of the rudder reduces yawing of the vessel. The installation of secondary rudders is therefore concluded to improve the maneuverability of icebreakers, especially when maximum a_y is used in steering the vessel. DLC.

Acknowledgement: Arctic Institute of North America
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

10 0376

United States. Coast Guard. (1973). **Hull lubrication for icebreaking on the (WYTM) RARITAN.** *Washington, D.C.: USCG, office of Research and Development. Final report no. 731342. 95 pp.*

The final report is made of field test performance by a Coast Guard test team aboard the RARITAN, a 110 foot WYTM class ship used for winter icebreaking. The ship was modified with a water hull lubrication system and an air bubbler system. The report begins with a discussion of the hull lubrication concept and why it was employed. It then describes the hardware design and instrumentation. The design and experimentation is discussed in some detail and a portion of the report is devoted to environmental studies that were done in conjunction with the testing. The report concludes with conclusions and recommendations. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-757 937
Price: $8.00 U.S.

10 0377

Vance, George P. (1980). **Analysis of the performance of a 140-foot Great Lakes Icebreaker: USCGC Katmai Bay.** *Hanover, N.H.: Cold Regions Research and Engineering Lab. Report no. CRREL-80-8. 37 pp.*

This report presents the results of the tests on the new U.S. Coast Guard 140-ft icebreaker Katmai Bay (WTGB-101) in the level plate ice and brash ice in Whitefish Bay and the St. Marys River. The results indicate that the vessel can penetrate 22 in. of level freshwater ice with 2-3 in. of snow cover. It can also penetrate up to 48 in. of brash ice in a continuous mode and at least 30 in. of plate ice by backing and ramming. The installed bubbler system decreased the required power of the vessel from 10 to 30% in brash ice and 25 to 35% in level ice. The low friction coating appears to be effective in decreasing the friction factor when it remains intact; when it peels off it appears to make conditions worse than plain paint. An average dynamic friction factor of 0.15 could be used over the entire hull for these tests. (Author).

Acknowledgement: NTIS
Available from: NTIS: cite AD-A084 736/8
Price: $6.00 U.S.

10 0378

Voelker, R.P., F.W. DeBord and K.E. Dane. (1979). **Operational assessment of commercial icebreaking ships in Western Alaskan waters, based on April 1979 USCG POLAR class trafficability test data. Volume II.** *Columbia, Md.: ARCTEC Inc. Final report. Report no. 500C-1-VOL-2. 115 pp.*

Environmental and ship performance data were collected aboard the USCGC POLAR SEA in April 1979 as part of a two year program to make an operational assessment of the feasibility of a year-round transportation system serving northwestern Alaska. The POLAR SEA successfully operated through the North Bering Sea, Bering Strait, and South Chukchi Sea during this time period. From an analysis of the governing ice conditions and the capability of the ship, it has been concluded that the POLAR Class icebreakers have the capability to operate year-round in the North Bering Sea. Three commercial icebreaking ships (MV ARCTIC, SS MANHATTAN, and a proposed Arctic tanker) were also evaluated to determine their ability to successfully operate along potential marine routes in Western Alaska. Volume II contains the appendices to the report including data summaries, calculations, thickness measurements, and a description of the methods used to classify the data.

Acknowledgement: NTIS
Available from: NTIS: cite PB80-145105

10 0379

Voelker, R.P., F.W. DeBord and D.E. Dane. (1979). **SS Manhattan Arctic marine project: executive summary.** *Columbia, Md. ARCTEC Inc. Report no. 375C-1. 116 pp.*

Available from: See Introduction "Availability of documents" Item (a)

10 0380

Wade, R.G., R.Y. Edwards and J.K. Kim. (1975). **Improvements in icebreaking by use of air cushion technology.** *New York, N.Y.: Society of Naval Architects and Marine Engineers. Paper presented at the Ice Tech Symposium, Montreal, Canada, April 9-11, 1975. 14 pp.*

Full scale observations of icebreaking operations of air cushion vehicles over the period of 1971-1974 are discussed. Limited data from these trials is used to substantiate the hypothesis that an ACV will progress continually through an ice cover, breaking it up as thoroughly as an icebreaker, provided (a) the vehicle cushion pressure, expressed as a head, exceeds that weight which would create ultimate collapse of the ice cover. Model tests are described which were conducted to assess the capability of an air cushion device deployed at the bow of an icebreaking ship to decrease the resistance encountered by that ship as the combination proceeds through a field of uniformly thick plate ice. The tests showed that the resistance of a model of the CCGS NORMAN McLEOD ROGERS equipped with an air cushion device was reduced by 22-42 percent (depending on ship speed) below the resistance which would be encountered without the ACV. The implications of the findings of these full scale and model test programs on cold regions ship operations are significant and are discussed.

Acknowledgement: SNAME
Available from: SNAME

10 0381

Welsh, J.P., Jr. (1978). **Test and evaluation of CGC Polar Star WAGB 10: Volume I Antarctic trials.** *NSTL Station, Miss.: Naval Ocean Research and Development Activity. Final report. Report no. NORDA Report 22. 188 pp.*

CGC Polar Star is the first of a new class of American icebreakers built for and operated by the U.S. Coast Guard. The vessel's design incorporates many new and sophisticated systems not found on earlier icebreakers. The primariry objective of the test and evaluation program was to examine the performance characteristics under actual polar operations. Two field trials were conducted. The first in the Arctic and the second in the Antarctic. During these field trials approximately 120 individual parameters were measured and recorded on magnetic tape. Additionally, the physical properties of the sea ice in which the ship was operating were measured. Documentation of the complete program including preliminary screening of the data has been accomplished by NORDA under contract to the Coast Guard Research and Development Center. The documentation consists of the following four volumes: I. Antarctic Trials, II. Test Plans, III. Background, and IV. Instrumentation Manual. Prepared for U.S. Coast Guard Research and Development Center, Groton, Connecticut.

Acknowledgement: MRIS
Available from: NORDA

10 0689

Arctec Canada Ltd. (1976). **Results of full-scale trials in ice of the CCGS "Wolfe" II.** *Kanata, Ont.: Arctec.*

Previous research, which included model tests, had indicated that the icebreaking capability of the icebreaker CCGS "WOLFE" would be enhanced if the ship were fitted with a new bow which would decrease the waterline angle from 26b0 to 16b0. Full scale trials were held before and after the refit (1969 and 1976/77 respectively) to verify the model test findings.

The specific objectives of the trials were to measure icebreaking forces in relation to ice thickness, ship speeds and propeller revolutions in sea ice and to investigate the effect of snow cover over the ice. Force measurements were also taken in the continuous icebreaking mode and deceleration measurements were made for discontinuous icebreaking operations.

Available from: TDC Library, Montreal

11 Ship/Ice Interaction (Including Offshore Structures)

11 0382

Assur, A. (1971). **Forces in moving ice fields.** *Abstract of paper delivered at the IST International Conference on Port and Ocean Engineering under Arctic Conditions, Trondheim, Norway, August 23-30, 1971. Trondheim: Technical University of Norway.*

One of the biggest problems confronting the designer of structures in ice infested waters is the proper design against forces exerted by moving ice fields. Little, if any, experimental data have been available until recently, only a few model tests have been conducted. The situation is even more complicated if one considers that ice formations attacking structures, especially in oceans, hardly satisfy the theoretical requirements of a well defined geometry. For example, pressure ridges, especially old, healed pressure ridges in the Arctic pack ice can exert tremendous forces, ice pileup on structures can modify their response to moving ice fields. Some insight can be gained from systematic observations made from ships negotiating various ice formations since the applied thrust can be calculated. The geometry of the ship bow, however, can be vastly different from the geometry of various structures and harbor installations. The paper presents a systematic discussion starting from the simplest cases up to more complex situations confronted by the designer. The calculation of relevant properties of ice sheets depending upon temperature and salinity is briefly outlined and it is shown how to extrapolate information obtained from one set of conditions to harsher conditions in other locations. The effect of the geometry of structures upon ice forces is shown starting from vertical and sloping cylinders, piles and walls. It appears that the mode of failure, such as buckling, crushing, bending and splitting is governed by the relationship of structure geometry to ice thickness. The relative efficiency of conical structures to combat ice forces is severely impaired by the possibility of ice-up which is discussed in detail and compared with field observations on causeways and similar structures A possible way to calculate critical ice forces in the presence of this rather chaotic situation is outlined including overturning and possibly torsional moments. This requires a statistical approach. It is shown how to relate such forces to the forces originating between moving ice fields which eventually lead to pressure ridges. Ship observations give rather reliable indication about the relative forces to be expected from various ice formations observed in nature. Available information is summarized and various approaches are discussed.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0383

Assur, A. (1975). **Problems in ice engineering.** *In International Symposium of Ice Problems, 3rd, Hanover, New Hampshire, August 18-21, 1975. Proceedings. Report no. MP 836, pp. 361-372. [S.I.]: International Association of Hydraulic Research.*

The design of large structures in ice infested water such as piers, offshore terminals and platforms is subject to considerable uncertainties due to lack of suitable data and experience. However, observations on ships provide clues for some of the most serious problems to be solved. This paper discusses the effect of friction, adfreezing, side pressure and forces on random ice agglomerations. Horizontal ice pressure can stop ships, so can "ice pillows" under moderate ice conditions.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0384

Atkins, A.G. (1975). **Icebreaking modeling.** *Journal of Ship Research 19(1): 40-43.*

Available from: See Introduction "Availability of documents" Item (b)

11 0385

Atkins, A.G. and R.M. Caddell. (1974). **Laws of similitude and crack propagation.** *International Journal of Mechanical Sciences 16(August): 541-548.*

Available from: See Introduction "Availability of documents" Item (b)

11 0386

Beek, G.H.M. (1976). **Strength considerations in controllable pitch propeller design.** *International Shipbuilding Progress 23(266): 329-341.*

Available from: See Introduction "Availability of documents" Item (b)

11 0387

Belen'kii, L.M. (1976). **Determining the maximum local loads acting upon the ship hull.** *Soviet Shipbuilding 1976 No. 4 (Pub. Sept. 1976): 11-18.*

Available from: See Introduction "Availability of documents" Item (b)

11 0388

Berenger, D., B. Michel and R.Y. Edwards. (1974). **Ice impact load on ships, vol. 2: ice conditions and properties in the St. Lawrence River and Gulf.** *Montreal: Arctec Canada Ltd.*

Available from: TC Library, Ottawa (Interlibrary loan)

11 0389

Bernard, Michel. (1970). **Cold Regions Science and Engineering Monograph 3, Section B1b: ice pressure on engineering structures.** *Hanover, N.H.: CRREL. Report no. CRREL-CRSE-3-B1b. 80 pp.*

The monograph summarizes existing knowledge on forces exerted by an expanding ice sheet, impact forces of ice on structures, and vertical forces exerted by ice on hydraulic structures. Sections are also devoted to icebreakers and ice models. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-709-625
Price: $8.00 U.S.

11 0390

Bock, R. et al. (1973). **Ice effects on structures and navigation and methods of ice control.** *In International Congress of Navigation, 23rd. Report, Section II, Subject 4, pp. 81-110.*

Brussels, Belgium: Permanent International Association of Navigation Congresses, 1973.

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0391

Bogororodskii, P.V. and V.P. Gavrilo. (1979). **Noise accompanying the breakup of ice by the hull of an icebreaker**. *Soviet Physics. Acoustics 25(1): 73-74.*

Available from: See Introduction "Availability of documents" Item (b)

11 0392

Bradford, J.D. (1971). **Sea ice pressure generation and its effect on navigation in the Gulf of St. Lawrence area**. *Institute of Navigation. Journal. [London] 24(4): 512-520*

Available from: See Introduction "Availability of documents" Item (b)

11 0393

Bradford, J.D. (1972). **Preliminary report of the observations of sea ice pressure and its effect on merchant vessels under icebreaker escort**. *In Proceedings of the International Conference on Sea Ice, Reykjavik, Iceland, May 10-13, 1971, pp. 154-158. Reykjavik, Iceland: National Research Council, 1972.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0394

Bradford, J.D. (1972). **Sea ice pressures observed on the second "Manhattan" voyage**. *Arctic 25(1): 34-39.*

Available from: See Introduction "Availability of documents" Item (b)

11 0395

Brown, Colin B., Jacques M. Laurent and James R. Tilton. (1977). **Beam-plate system on Winkler foundation**. *ASCE Journal of the Engineering Mechanics Division 103(4): 589-600.*

A superposition principle is employed to study the infinite plate reinforced by a centrally loaded finite beam where both rest on a Winkler foundation. The problem is intended to relate to a floating arctic ice ridge embedded in an ice sheet. The ridge is loaded vertically by a vessel breaking ice in a bending mode. After formulating the beam and plate problems separately, connectivity conditions are imposed to link the two parts. The Fourier transform of the plate equations provides the solution technique. Computation of the resulting integrals are completed by the Fast Fourier Transform algorithm. An application to arctic ridges provides the ridge and sheet properties necessary for the finite ridge solution to be essentially the same as that of the infinite ridge. Then the infinite ridge is considered and the proportion of the load isostatically resisted by the ridge and the sheet determined.

Acknowledgement: Engineering Index

Available from: See Introduction "Availability of documents" Item (b)

11 0396

Bryson, F.E. (1975). **Breaking the ice barrier**. *Machine Design 47(3): 20-25.*

Two predictor equations for icebreaker hull shapes have evolved from model basin tests. Both equations were derived from multiple regression techniques using raw data. Neither equation can account for hull roughness. The installation of air bubbler manifolds along the turn-of-the-bilge line in bulk carriers enables them to make passage through brash without becoming stuck.

Acknowledgement: Engineering Index

Available from: See Introduction "Availability of documents" Item (b)

11 0397

*Buzuev, A. IA. and A. IA. Ryvlin. (1969). O raschetakh soprotivleniia l'da dvizheniiu ledokola pri razlichnykh ledovykh usloviiakh. [***Calculating ice resistance to icebreaker movement under various ice conditions***.] Problemy Arktiki i Antarktiki sbornik statei, 1969 Vol. 31: 69-73. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0398

*Buzuev, A. IA. and A. IA. Ryvlin. (1976). Uchet neravnomernosti raspredeleniia kharakteristik ledianogo pokrova pri otsenke ledoprokhodimosti sudov. [***Non-uniformity of ice cover characteristics as a factor in dertermining navigability through ice***.] Meteorologiia i gidrologiia, Apr. 1976 No. 4: p. 68-73. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0399

Calabrese, S.J. and F.F. Ling. (1978). **Low friction coatings for icebreakers**. *Washington, D.C.: U.S. Coast Guard. Phase III technical report. Report no. USCG-D-69-78. 192 pp.*

Available from: See Introduction "Availability of documents" Item (a)

11 0400

Calabrese, S.J., R. Buxton and G. Marsh. (1979). **Frictional characteristics of materials sliding against ice**. *Preprint no. 79-AM-3B-2 presented at the ASLE Annual Meeting, 34th, St. Louis, Mo., April 30-May 3, 1979. Park Ridge, Ill.: American Society of Lubrication Engineers, 1979. 7 pp.*

This paper presents some of the more important conclusions of a study to find abrasion-resistant, low friction coatings which can be used on the hulls of U.S. Coast Guard icebreakers. Basic studies showed that there are several parameters which affect the friction of materials sliding on ice, including surface roughness, relative humidity and velocity. Laboratory tests were made to evaluate the friction and abrasion resistance of over 200 coating materials. Based on the results obtained, two nonsolvented polymer coatings were selected for full-scale ship evaluations. Both coating materials have remained over 90 percent intact on the hull of an icebreaker for two years or more. One material, a nonsolvented polyurethane, has been effective in protecting the hull for four years and shows a reduction in hull resistance in ice after two years of service. 6 refs.

Acknowledgement: Engineering Index

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0401

Calabrese, S.J., M.B. Peterson and F.F. Ling. (1974). **Low friction coatings for icebreakers**. *Washington, D.C.: U.S. Coast Guard. Technical report on phase I. Report no. USCG-D-107-74. 159 pp.*

Part I of the first phase of development of low friction coatings for icebreakers involved the evaluation of State-of-the-Art coatings available from industry. Laboratory simulation tests were conducted to determine materials and scratch resistance as well as quantifying various frictional properties of the materials with varying ice properties. Several coatings were selected out of over 100 samples tested for application icebreakers. Part II of Phase I the coatings selected in Part I were applied to small icebreakers for initial full scale evaluation. Tests described and results discussed. (Author)

Acknowledgement: NTIS

Available from: NTIS: cite AD-784 361/8
Price: $11.00 U.S.

11 0402

Calabrese, S.J., M.B. Peterson and F.F. Ling. (1976). **Low friction hull coatings for icebreakers: phase II, parts I and II — Laboratory and field tests.** *Troy, N.Y.: Rensselaer Polytechnic Inst. Technical report June 74 - Oct. 75. 90 pp.*

Part I of Phase II involved a laboratory evaluation of coatings. Simulation tests were conducted to determine the effect of velocity, humidity, temperature, coating thickness, and contact area on ice friction. From these results, the friction resistance of the hull of an icebreaker was theorized. New materials were also evaluated for possible future use as coatings; and a study of the coating application procedure was conducted. Part II of Phase II was full-scale evaluation of coatings applied to small icebreakers. This was a continuation of testing done in Part II of Phase I. A solventless polyurethane was found to be a good icebreaker hull coating. Part III — under separate cover; is an analysis of icebreaking in particulate (slush) ice.

Acknowledgement: NTIS
Available from: NTIS: cite AD-A024 847/6ST
Price: $10.50 U.S.

11 0404

Den Hartog, S.L. (1971). **SS Manhattan tests: a review of the ice program.** *In Proceedings of the 1st International Conference on Port and Ocean Engineering under Arctic Conditions, Trondheim, Norway, August 23-30, 1971, vol. 1, pp. 101-111. Report no. MP555. Trondheim: Technical University of Norway.*

The U.S. Army Cold Regions Research and Engineering Laboratory was contracted by Humble Oil Company to plan and supervise the ice testing aspects of their arctic tanker tests aboard the SS Manhattan. Since the prime procedure of the entire test program was to derive thrust and resistance values for varying ice types, USACRREL's responsibility was to define the ice conditions encountered. While the ship was underway in ice, a continuous description (log) of ice conditions, speed, propeller rpm, etc. was maintained. For formal tests ice thickness was measured at adequate intervals to define the sheet over the test section. Total channel width, size of cusps and other parameters were also noted. The major effort for formal tests was to measure the ice strength to enable comparison of tests in floes of equal thickness. Temperature and salinity profiles of the ice sheet were taken which could be used indirectly to measure ice strength. Frazil tensile tests were made to measure the strength directly but, as with all small sample ice testing, there was a large scatter in the results. A least squares fit of the Frazil data vs brine volume as determined from the temperature salinity measurements gives the following relationship: Frazil tensile strength in kg/sq cm is equal to 4.82 minus 5.68 times the square root of the brine volume. To compare the strength of one ice sheet to another for purposes of correlating ship tests it appears that brine volume measurements should be used rather than small sample tests. Although the relationship between brine volume and strength is not precisely known there is far less scatter in the brine volume measurements.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0405

Dunne, M. and P. Noble. (1977). **Results of full-scale ice impact load studies aboard CCGS Norman McLeod Rogers.** *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions, Memorial University of Newfoundland, St. John's, Nfld., September 26-30, 1977, Vol. 1, pp. 440-452. St. John's, Nfld.: The University, Ocean Engineering Information Centre.*

In order to develop new safety standards and regulations for the movement of ships in ice-infested waters, the Canadian Department of Transport initiated in 1974 an overall study of ice problems affecting the operation of ships in the St. Lawrence System. The study included the assessment of ice conditions in critical reaches, the development of an analytical predictive model, full scale impact load measurements and physical modeling of ice impact loading. The mathematical model was completed in April 1974. The present paper describes the instrumentation and test procedures used during a programme of full-scale measurements of impact loads carried out in the course of normal icebreaking operations by the CCGS Norman McLeod Rogers. The results of measurements of impact loads, ship speed and mean ice thickness are summarized for a total of 84 runs. It is concluded that the instrumentation gives realistic results but that further refinement of the mathematical model will be necessary.

Acknowledgement: BSRA
Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0406

Edwards, R.Y. Jr. et al. (1973). **Measurement of resistance, ice loads, and ice characteristics on the USCGC MACKINAW.** *Waltham, Mass.: Teledyne Materials Research. Final report Nov. 70 - July 71. Report no. E-1364(f). 105 pp.*

Experimental runs were made in ice of varying thickness at a number of different velocities and power levels to determine the effects of these and other varibles on the resistance encountered by the ship. In addition, measurements of strain were made on the hull from which the force exerted on the hull by the ice was determined for each data point. The relationship force to other variables was also developed. The results of the trials are presented in the form of functions of a number of nondimensional variables. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-759 952
Price: $9.00 U.S.

11 0407

Edwards, R.Y., Jr. (1976). **Methods for predicting forces encountered by propellors during interactions with ice.** *International Shipbuilding Progress 23(268): 406-419.*

A model system for estimating the shaft torque, blade bending moment and blade turning moment experienced by a propulsion system in ice has been developed. It produces results comparable with limited full scale observations. The primary variables which influence the level of ice forces, torques and moments on propellers are: angle of attack (a/v), maximum depth of cut, compressive strength of ice, pitch angle. It appears feasible, using this modeling system, to examine the effect of variations in blade number, blade area ratio, design pitch on propulsion system vulnerability. The physical model produces results for regions of propeller operation not heretofore covered by the mathematical model.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

11 0408

Edwards, R.Y., Jr. (1980). **Modeling the interaction between ice and ships.** *Proceedings of the Symposium on Physics and Mechanics of Ice, Copenhagen, August 6-10, 1979, pp. 60-81. Berlin: Springer-Verlag, 1980.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0409

Edwards, R.Y. and J.W. Wheaton. (1972). **Experimental determination of ice impact loads on marine vehicles.** *In*

Symposium on Ice and its Action on Hydraulic Structures, 2nd, Leningrad, September 26-29, 1972: Papers, vol. 1, pp. 51-61.

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0410

Edwards, R.Y., R. Abdelnour and M. Dunne. (1976). **Results of full scale ice impact load studies aboard CCGS Norman McLeod Rogers**. *Montreal, Quebec: Arctec Canada Ltd. 1 vol.*

Available from: TDC Library, Montreal (Interlibrary loan)

11 0411

Edwards, R. Y., Jr. et al. (1972). **Full-scale and model tests of a Great Lakes icebreaker**. *New York, N.Y.: Society of Naval Architects and Marine Engineers. Paper no. 5, presented at SNAME Annual meeting. 31 pp.*

The U.S. Coast Guard has formulated a research to provide design information for future icebreakers. Part of this program was a combined model and full-scale experiment involving a Great Lakes icebreaker, the USCGC "Mackinaw". The experiment was designed to collect data on the resistance to the motion of icebreakers and to evaluate the feasibility of developing a rational technique for estimating loads exerted on an icebreaker's hull during impact with the ice. The resistance of ice to the motion of the "Mackinaw" was determined during an extensive full-scale test. Ice resistance experiments were performed on a 1/48th scale model of "Mackinaw" in saline model ice at the ARCTEC Ice Model Basin. Model and full-scale test results were compared. The full-scale performance of the USCGC "Mackinaw" was compared with that of the Wind Class icebreaker to assess the effects of ice strength on resistance. The effectiveness as an ice resistance reducing device of the "Mackinaw" single bow propeller was evaluated. Impact loads on a portion of the ship's hull were measured and related to ship speed, ice thickness, and ice strength. Dimensionless groups, extracted from dimensional analysis of the hull ice interaction phenomenon, explain well the model and full-scale resistance data and full scale impact load data. Model and full-scale resistance data correlate well at low Froude number (v/square root of gh). The comparison of the "Mackinaw" and "Wind" Class ice resistance revealed a distinct difference in performance but ice strength effects appear small.

Acknowledgement: SNAME
Available from: SNAME

11 0412

Edwards, R.Y. et al. (1976). **Influence of major characteristics of icebreaker hulls on the powering requirements and maneuverability in ice**. *New York, N.Y.: Society of Naval Architects and Marine Engineers. 39 pp. Paper presented at the Society of Naval Architects and Marine Engineers Annual Meeting, New York, N.Y., November 11-13, 1976.*

Available from: SNAME

11 0413

Eliseev, V.K. (1970). **On the influence of the principal dimensions of an icebreaker hull on ice resistance**. *Problems of the Arctic and Antarctic 29-32: 496-500.*

Available from: See Introduction "Availability of documents" Item (b)

11 0414

Enkvist, E. (1972). **On the ice resistance encountered by ships operating in the continuous mode of icebreaking**. *[Helsinki]: Swedish Academy of Engineering Sciences in Finland. Report no. 24. 181 pp.*

Available from: TC Library, Ottawa (Interlibrary loan)

11 0415

Enkvist, E., P. Varsta and K. Riska. (1979). **Ship-ice interaction**. *In Proceedings of the 5th International Conference on Port and Ocean Engineering under Arctic Conditions, Trondheim, Norway, August 13-18, 1979, vol. 2, pp. 977-1002. Trondheim, Norway: The University.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0416

Filichev, IU. (1968). Povrezhdenie vintov v ledovykh usloviiakh. **[Breakage of ship propellers during ice navigation.]** *Morskoi flot, April 1968, No. 4: p. 21-22. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

11 0417

Furio, A.J., Jr. and W.E. Gilbert. (1974). **Impact tests of urethane foam**. *Bethesda, Md.: Naval Ship Research and Development Center, Structures Dept. Report no. 4254. 36 pp.*

The impact behavior of a low-density urethane foam was investigated experimentally, and the crushing characteristics of the rigid closed-cell foam were determined as a function of impact velocity, foam sample thickness, and temperature. The dynamic crushing strength of the material was found to be much better than its static strength. This energy-absorbing capability allows consideration of the foam as protection for the underbodies of Arctic surface effect vehicles (ASEV) against the impact of collisions.

Acknowledgement: MRIS
Available from: NTIS

11 0418

German and Milne. (1973). **Report on tests to measure ice forces on the hull of an icebreaker and the penetration of an icebreaker in ice**. *Montreal: German and Milne.*

Available from: TC Library, Ottawa (Interlibrary loan)

11 0419

Gerwick, B.C., Jr. (1975). **Prestressed concrete floating terminal for Arctic Ocean Service**. *In Proceedings of the 3rd International Conference on Port and Ocean Engineering under Arctic Conditions, Fairbanks, Alaska, August 11-15, 1975, v. 1, pp. 581-595. Fairbanks: University of Alaska, 1976.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0420

Gerwick, B.C. (1976). **Proposed prestressed concrete floating terminal for Arctic ocean service**. *In Proceedings of the Conference on Concrete Ships and Floating Structures, University of California, Berkeley, Calif., September 15-19, 1975, pp. 179-184. Berkeley, Calif.: The University.*

Construction of a very large prestressed concrete barge, using its mass, shape, and length in effective combination to continuously break the ice, and able to mode laterally in the event of ice-island encounter is contemplated. The first component of a terminal structure, the floating terminal is explored, and possible solutions are suggested for the subsequent components of mooring, riser, and offloading connections, needed to make the system viable.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0421

Gerwick, B.C., Jr. and L.B. Karp. (1979). **Icebreaker experience as a guide to sea ice forces on structures**. *In Proceedings of the Conference on Civil Engineering in the Oceans, 4th, San Francisco, Calif., September 10-12, 1979, vol. 2, pp. 622-637. New York, N.Y.: American Society of civil Engineers.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0422

Hakala, Matti K. (1979). **Nonlinear finite element analysis of an ice-strengthened ship shell structure**. *In International Conference on Engineering Application of the Finite element Method, Hovik, Norway, May 9-11, 1979, vol. 2. Hovik, Norway: A.S. Computas.*

Finite element method is used to study the nonlinear behaviour of an ice-strengthened ship shell structure. The main object is the plastification and collapse of a frame. The plastic limit load for this frame is determined using the calculated load-deflection curve. The results of the finite element analysis are compared with well-known formulas of plastic design and also with experimental results.

Acknowledgement: Engineering Index

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0423

*IAkonovskii, S.V. and A.N. Smirnov. (1968). Vliianie geometricheskikh i kinematicheskikh parametrov grebnogo vinta na velichinu vneshnikh sil, deistvuiushchikh na vint ledokola pri udare o led. [***Effect of geometric and kinematic parameters of a propellor on the magnitude of exterior forces acting on the icebreaker propeller when colliding with ice***.*] *Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1968 Vol. 93: 38-55. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0424

*Ignat'ev, M.A. (1966). Grebnye vinty sudov ludovogo plavaniia; osobennosti proektirovaniia. [***Ship propellers for ice navigation vessels; features of design***.*] *Leningrad: Izd-vo Sudostroenie, 1966. (In Russian.)*

Presents data for designing propellers of icebreakers and transport vessels for ice navigation, as assembled from laboratory and field investigations of propeller performance in arctic ice, and from icebreaker fleet experience along the Northern Sea Route. Specific features in designing ice navigation propellers (with calculation graphs), analysis of propeller damage and calculation of the propeller blades are dealt with in the first two chapters. The third and fourth discuss the strength of outboard propeller shaft; and performance of the tractor-propeller. In chapter 5 measures for improving ice-transit ability and maneuverability are discussed, and the last chapter gives the calculation of propellers for a 36,000 hp icebreaker, the blade strength, and diameter of the propeller shaft. DLC.

Acknowledgement: Arctic Institute of North America

Available from: See Introduction "Availability of documents" Item (a)

11 0425

*Ignat'ev, M. (1967). Predokhranenie grebnykh vintov ot ledovykh povrezhdenii. [***Protecting ship propellers from ice damage***.*] *Morskoi flot, Feb. 1967, No. 2: p. 23-24. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

11 0426

Inerta 160-a bottom coating system for super heavy duty. *(1979). Shipbuilding and Marine Engineering International 102 (May): 184.*

Friction between the hull and the ice is a primary factor of ship resistance in ice, and calls for bottom coatings that will withstand ice abrasion, particularly near the waterline. Inertia 160, the special hull-coating developed for ice-going ships by Teknos-Maalit Oy, the Finnish associate of International Marine Coatings, has successfully under gone a number of comparative tests with other coatings, both in the laboratory and fullscale, and over 140 vessels have been coated with it since 1972. The article outlines the results of full-scale tests on this coating, carried out during the normal operation of icebreakers and other ice-going ships. Service testing described includes that by the sister ships Sisu and Urho Finland's largest icebreakers: Sisu was coated with Inerta 160 and Urho with a competing system (a solvent-free epoxy); after two years' operation, the Inerta 160 was still in very good condition, but the epoxy coating showed nearly total collapse. The article also outlines some service tests by the U.S. Coast Guard and some laboratory tests in which Inerta 160 was compared with a polyurethane system. Among the ships that have been bottom-coated with Inerta 160 is the Wartsila-built high-speed Baltic ferry Finnjet; about 6,000 sq m was coated, and two years later (after one winter in service) this was still intact. The article also includes brief information on the method of application (stated to be complicated but worthwhile) of this coating, and on its advantages in relation to fuel consumption and repair costs.

Acknowledgement: BSRA

Available from: See Introduction "Availability of documents" Item (b)

11 0427

*Ivanov, L.V. (1978). Zimniaia ekspluatatsiia ob'ektov vodnogo transporta. [***Winter operation of water navigation objects***.*] *Moscow: Transport, 1978. 211 pp. (In Russian with English table of contents encosed.)*

Available from: See Introduction "Availability of documents" Item (a)

11 0428

Juurmaa, Kimmo. (1978). **The Wartsila air bubbling system**. *Polar Record 19(119): 121-127.*

The system works to reduce the friction between the ship's hull and the ice or snow. A mixed flow of air bubbles and water is produced, arising from compressed air being forced through a series of nozzles placed at specified intervals near the bottom of the ship. When the air rises along the hull, in the form of bubbles, it creates a strong current of water and air which forms a layer between the hull and the ice consequently reducing ice resistance in most ice conditions. (Author).

Available from: See Introduction "Availability of documents" Item (b)

11 0429

*Kamenetskii, I.IA., Z.I. Shvaishtein and A.A. Sergeeva. (1971). Adgeziia l'da k palubnym pokrytiiam, ispol'zovannym kak sredstvo bor'by s obledeneniem sudov. [***Ice adhesion to the coatings protecting ship decks from icing***.*] *In Teoreticheskie i eksperimental'nye issledovannia uslovii obledeneniia sudov (Theoretical and experimental studies of ship icing): p. 134-145. (In Russian.) Leningrad: Gidrometeoizdat, 1971.*

Available from: See Introduction "Availability of documents" Items (a) and (d)

11 0430

Kashtelian, V.I. (1973). **Methods of estimating the ice navigating capability of a ship in solid ice.** *In Ice navigation qualities of ships. CRREL Report no. TL-417. pp. 3-18. (See entry no. 11 0438)*

Available from: See entry no. 11 0438

11 0431

*Kashtelian, V.I. and IU.N. Popov. (1970). Issledovaniia v oblasti vzaimodeistviia korpusa sudna so l'dom. [***Studying interaction between ice and the frame of a ship.***] Problemy Arktiki i Antarktiki Sbornik statei, 1970 Vol. 36-37: 153-159. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0432

*Kashtelyan, V.I., I.I. Posnyak and A.Y. Ryvlin. (1968). Soprotivlenie l'da dvizheniiu sudna. [***Resistance of ice to ship movement.***] [Leningrad]: Sudostroyeniye. 237 pp. (In Russian.)*

Modern methods of calculating the resistance of ice to ship movement are presented. Generalized results of theoretical experimental work in this area are given. Problems of modeling ship movement in various types of ice are examined, and the methodology and technology of carrying out tests with ship models in an experimental ice basin are covered. The interrelationship between the main characteristics of a ship and ice parameters is examined, and practical methods of calculating a ships speed in ice taking into account the natural characteristics of the ice cover, the strength of the ships hull, and the size of its power plant are given. The methods of calculating ice resistance are original and have been developed by the authors over a period of years on the basis of theoretical and experimental research carried out under natural conditions and in experimental ice basins. Brief data are also presented on icebreakers, transport ships for polar navigation and their ice-breaking capacity, and also data on sea ice, its classification, and its physical and mechanical properties. Recommendations are given for designing the lines of ship hulls for polar navigation for selecting the main dimensions, and for determining the size of the power plant. For the first time, a series of complex questions connected with ship navigation in various types of ice are systematically answered permitting basic decisions to be made on the proper shape of icebreaker and polar ship hulls. The monograph is intended for engineers and technicians in the ship building industry.

Acknowledgement: MRIS

Available from: Library of Congress Photoduplication Service Washington D.C. 20540

11 0433

Keys, J., and S.D. Smith. (1970). **Frictional resistance to a ship's passage through converging ice.** *Arctic 23(4): 284-285.*

The report describes a numerical method for calculating the frictional resistance encountered by a vessel navigating in a converging ice field.

Acknowledgement: NTIS

Available from: See Introduction "Availability of documents" Item (b)

11 0434

*Kheisin, D.E. (1966). K opredeleniiu kontaktnykh davlenii, deistvuiushchikh v zone udara sudna o led. [***Determination of contact pressures in the zone of ship-ice impact.***] Problemy Arktiki i Antarktiki 1966 no. 22: 96-102. (In Russian.)*

Studies the effect of impact time, ship's displacement and body contour on the value of the collision contact pressure. A new physical model of the mechanism of crumbling of the ice edge upon collision contact with the vessel is proposed, assuming the presence of an intermediary layer at the contact zone. Contact pressures determined on the basis of an intermediary layer are found to depend on the depth of crumbling and the velocity. DLC.

Acknowledgement: Arctic Institute of North America

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0435

Kheisin, D.E. (1973). **Elastic oscillations of a ship's hull in the effect of random pulsed ice loads.** *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 153-159. (See entry no. 11 0438)*

Available from: See entry no. 11 0438

11 0436

Kheisin, D.E. (1973). **On the ice navigation speed of ships in extremely solid ice.** *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 19-30. (See entry no. 11 0438)*

The stability of the motion of a ship in solid ice with a thickness close to the limiting thickness is investigated. The probability of stopping for given intervals of time is estimated. An estimate is given of the dispersion of the force of the ice resistance according to a three-point static scheme of ice-breaking. Dimensionless parameters are introduced that make it possible to compare the ice navigation speed (ice navigating capability) of ships of the same type. Calculated thickness of ice broken for various ships, including the (Lena) are tabulated.

Acknowledgement: CRREL

Available from: See entry no. 11 0438

11 0437

Kheisin, D.E. (1973). **Use of probability methods in estimating the maneuvering qualities of ships in ice.** *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 40-58. (See entry no. 11 0438)*

Available from: See entry no. 11 0438

11 0438

Kheisin, D.E. and Y.N. Popov, eds. (1973). **Ice navigation qualities of ships.** *Hanover, N.H. Cold Regions Research and Engineering Laboratory. Report no. CRREL-TL417. 288 pp. Draft translation.*

The collection is devoted to the results of theoretical and experimental investigations of the ice qualities of ships, conducted at the Arctic and Antarctic Scientific Research Institute in the past decade. The basic attention is given to problems directly associated with ice navigating capability and strength. Navigating capability and maneuvering characteristics of ships in motion in solid ice is investigated. Together with the traditional experimental-theoretical approach to these problems, theoretical-probability methods of estimating ice navigation speed and maneuvering qualities of ships are developed, based on data from full-scale tests. An analysis of the process of wedging of an ice breaker in ice is also given. Where ice strength is referred to, the effect of the slope of the hull on the parameters of direct and reflected impacts is investigated, and various schemes for the calculation of elements of the side framing and shell plating are considered. Description and analysis of strain-gauge tests of the ice resistance of hulls of transport vessels and ice breakers is reported. (Modified author abstract).

Acknowledgement: NTIS

Available from: NTIS: cite AD-764807/4

11 0439

Kheisin, D.E., V.A. Likhomanov and V.A. Kurdiumov. (1976). **Determination of specific breakup energy and contact**

pressures produced by the impact of a solid against ice. *CRREL Report no. TL 539, August 1976, pp. 210-219. Hanover, N.H.: Cold Regions Research and Engineering Laboratory. (Translation).*

Available from: See Introduction "Availability of documents" Item (a)

11 0440

LeCourt, E.J. (1976). **Air bubbler system design for the 140 foot WYTM.** *Columbia, Md.: ARCTEC Inc. Design report 1975-1976. Report no. 202C-3. 39 pp.*

The 140' class of Coast Guard Cutters are equipped with an air bubbler hull lubrication system for ice breaking. The air bubbler system reduces ice friction against the cutter's hull plating. This report describes the air bubbler system on this class cutter, gives its operating characteristics, and its design history. (Author).

Acknowledgement: NTIS
Available from: NTIS: cite AD-A084 891/1
Price: $3.50 U.S.

11 0441

Levine, G.H., P.B. Mentz and W.R. Ransom. (1974). **Improving ship operations in ice covered waters.** *Marine Technology Society Journal 8(8): 54-57.*

Full-scale testing was performed during this past winter on the air coating system, which was conceived to improve the performance of ships operating in broken ice and mush ice. The Great Lakes ore carrier Leon Fraser was modified to accept this system after model tests had been used to optimize the design. A relatively mild winter resulted in insufficient build-up of broken ice in the channels to effectively test the system. The data which was obtained indicated that a potential exists for the air coating system to reduce resistance in broken ice and mush ice. Measurements were also made of ice forces on the hull structure caused by impacting sheet ice and by hitting ice floes. Results of these measurements have lead to the development of predictor equations for calculating ice forces.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (b)

11 0442

Levine, G.H., R.P. Voelker and P.B. Mentz. (1974). **Advances in the development of commercial ice-transiting ships.** *In Transactions of the Society of Naval Architects and Marine Engineers Vol. 82. 26 pp.*

Ice impact loads were recorded for two years aboard the ore carrier Leon Fraser operating between Lake Superior and Lake Michigan. The techniques of dimensional analysis were applied to these data to develop predictor equations which give ice forces as a function of ship form, speed, ice thickness, and ice strength. A series of icebreaking model tests was also performed on Great Lakes ore carriers and a predictor equation was developed which incorporates length, beam, and stem angle variation. Results of experiments directed toward the reduction of ship resistance in ice fields are also presented. This three-phase program included: model tests of various concepts to reduce ship resistance in broken ice-clogged channels, design and development of an air coating system, and full-scale testing of this system as installed in the Leon Fraser. Scenarios describing technical events leading to year-round commercial ship operations in the Great Lakes and Arctic regions are presented as well.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

11 0443

Likhomanov, V.A. and D.I. Solostianskii. (1973). **Strain-gauge tests of icebreaking transport vessels.** *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 128-135. (Translation). (See entry no. 11 0438)*

Available from: See entry no. 11 0438

11 0444

McIntosh, J.A. and W.J. Blanton. (1974). **Full scale icebreaking tests of a hull air coating system.** *Groton, Conn.: Coast Guard Research and Development Center. Final report. Report no. CGR/DC-23/74. 145 pp.*

This report describes the full-scale testing of an auxiliary system for improving the icebreaking performance of ships. The system consisted of a set of blowers and piping installed within and on the hull in such a way that the exterior of the ships' hull was covered from bow to stern and keel to waterline, with a layer of air bubblers. The purpose of the air flow was to entrain a flow of water which, in turn, would continuously wet the area of contact between the hull and the ice during icebreaking operations. It was anticipated that this would reduce the friction between the ice and the hull, and thus increase the speed of advance of the ship.

Acknowledgement: NTIS
Available from: NTIS: cite AD-A010 706/0ST
Price: $10.00 U.S.

11 0445

*Kirillov, A.A. and V.A. Spichkin. (1966). Metod rascheta srokov vozmozhnogo nachala nepreryvnogo dvizheniia ledokolov v sploshnykh l'dakh. [***A method of estimating when an icebreaker can make continuous transit through close pack ice.***] Problemy Arktiki i Antarktiki 1966 No. 22: 66-74. (In Russian.)*

Investigates the possibility of nonstop penetration at a given date in terms of ice thickness and strength. The ice-cover resistance to breaking is evaluated in terms of the icebreaker parameters, and the seasonal and year-to-year variation in ice resistivity. The proposed method can be used for determining the dates for different icebreakers to begin operations when their construction parameters are known.

Acknowledgement: Arctic Institute of North America
Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0446

Kotras, T.V., P.P. Kosterich and R.P. Voelker. (1977). **Ice impact forces on the bow of a Great Lakes bulk carrier.** *Columbia, Md.: ARCTEC Inc. Final report. Report no. 160C-2. 100 pp.*

Ice impact forces on the bow and shoulder of a Great Lakes bulk carrier were measured during the 1976 extended shipping season. These measured values were analyzed with ice impact forces obtained from previous tests aboard bulk carrier LEON FRASER and icebreaker USCGC MACHINAW to give a predictor equation which describes ice impact forces as a function of ice thickness, ship speed and hull shape.

Acknowledgement: NTIS
Available from: NTIS: cite PB-281696/5ST

11 0447

*Kuchiev, IU. (1968). Povrezhdenie vintov v ledovykh usloviiakh. [***Damage to ship propellers by ice.***] Morskoi flot Sept. 1968 No. 9: p. 18. (In Russian.)*

This is a critical discussion of the IU Filichev article published in Morskoi Flot, No. 4, 1968.

Acknowledgement: CRREL
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

11 0448

Kudishkin, V.S. (1973). **Excitation of vertical elastic oscillations of a ship's hull in motion in the ice.** *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 142-152. (Translation).*

Available from: See entry no. 11 0438

11 0449

Kudishkin, V.S. (1973). **On the distribution of probabilities of the number of impacts of a ship's hull against the ice.** *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 136-141. (Translation). (See entry no. 11 0438)*

Available from: See entry no. 11 0438

11 0450

*Kudishkin, V.S. (1978). Eksperimental'noe izuchenie ledovoi vibratsii d/e (Ob'). [***Experimental work on ice vibration in the (Ob').***] Sovetskaia antarkticheskaia ekspeditsiia. Trudy, 1978 Vo. 68: 140-143. (In Russian.)*

A method for studying hull vibration under ice conditions has been worked out. The initial results of the application of the method to vibration in the (Ob') hull in antarctic ice are presented.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0451

*Kudishkin, V.S. and N.G. Kosenko. (1978). Osobennosti vzaimodeistviia korpusa d/e (Ob') so l'dom pri szhatiiakh. [***Interaction of the hull of the (Ob') with compressed ice.***] Sovetskaia antarkticheskaia ekspeditsiia, Trudy. Trudy. 1978 Vol. 68: 133-139. (In Russian.)*

The (Ob') sustained extensive damage to parts of her hull when she was icebound for 90 days off the Oates Coast. The authors analyze the stress to which she was subject from floating ice, various wind and other weather conditions, and during her entrapment.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0452

Levine, G.H. et al. (1974). **Results from two years of testing a Great Lakes ore carrier in ice fields: volume I.** *Columbia, Md.: ARCTEC Inc. Final report July '72 - July '74. 153 pp.*

The effectiveness of an air coating system to reduce ore carrier resistance in brash ice fields and the ice forces on the bow of a Great Lakes ore carrier are presented as a result of a two year test program. Design of the air coating system and the ice force measurement system are described including the subsequent shipyard modification. A sample calculation to determine the economic benefits versus cost is also presented.

Acknowledgement: NTIS
Available from: NTIS: cite PB-267 407/5ST
Price: $11.00 U.S.

11 0453

Levine, G.H. et al. (1974). **Results from two years of testing a Great Lakes ore carrier in ice fields: volume II.** *Columbia, Md.: ARCTEC Inc. 121 pp.*

The report contains seven appendices: Leon Fraser principal characteristics and hull data; Locations of potential ice bottleneck areas; Air coating system test data; Strain gage system test data; Maneuvering tests with air coating system; Ice thickness measurements and observations in the St. Mary's River and Whitefish Bay, January-April 1974; Observed effective channel preparations.

Acknowledgement: NTIS
Available from: NTIS: cite PB-267408/3ST

11 0454

Major, R.A., D.M. Berenger and C.J.R. Lawrie. (1975). **A model to predict hull-ice impact loads in the St. Lawrence.** *In Proceedings of the Ice Tech Sympposium, Montreal, Canada, April 9-11, 1975, pp. D1-D23. New York, N.Y.: Society of Naval Architects and Marine Engineers, 1975.*

Channel deepening operations in the St. Lawrence River now make it possible for tankers in excess of 100,000 deadweight tons to call at Quebec City area refineries. Due to the increase in traffic and vessel size expected with this new channel, the Canadian Ministry of Transport has started a program to assess danger to ships due to ice conditions in the St. Lawrence River. This paper presents a study of St. Lawrence River and Gulf ice conditions with a mathematical model that predicts ice impact loads on ships under these conditions. For this prediction, the first step in the assessment program, the model was computerized and exercised. Model results obtained are compared to previous full-scale test results and agree favourably. Finally, predictions are presented for the ice loading on a typical VLCC in St. Lawrence ice. The model shows that ice impact actually causes greater pressures to be exerted on much more limited areas, than does the traditional hydrostatic approach to design loading.

Acknowledgement: SNAME
Available from: SNAME

11 0455

Major, R.A., T.V. Kotras and R.Y. Edwards. (1974). **Mathematical model for predicting ice forces on ship hulls, vol. 1: ice force model.** *Montreal: Arctec Canada Ltd.*

Available from: TC Library, Ottawa (Interlibrary loan)

11 0456

Makinen, E. (1976). **The importance of full-scale testing in ice for designing icebreaking ships.** *Schiff und Hafen 28(July): [n.p.]*

In this abridged version of a paper presented at the Schiffbautechnische Gesellschaft meeting held in Helsinki in June 1976, the Authors discusses the investigation of ships' ice-resistance, with particular reference to full-scale studies carried out by Wartsila. Full-scale testing has to form the basis of all icebreaking research, and it would be advantageous if all investigations could be carried out in this way alone. However, practical difficulties, including the length of time between design and delivery of a new ship-type, necessitate its use in association with model tests and analytical studies. Wartsila carry out full-scale tests in three different ice conditions: level ice, clogged channel, and level ice-field with ridges. In recent years, the company has been conducting trials with the aim of producing expressions for determining ships' ice-resistance under the different conditions; in these expressions, ice resistance is presented as a function of ship and environmental characteristics. Full-scale tests have been found to be essential for establishing the basic form of the expressions and for investigating the influence of environmental parameters. The paper includes a graph in which model and full-scale results are compared in respect of the effect of hull surface quality upon ice resistance.

Acknowledgement: BSRA
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

11 0457

Makinen, E., A. Keinonen and A. Laine. (1976). **Ice resistance**

measurements in ridges with I.B. APU in the Baltic Sea. *Ocean Engineering 3(October): n.p.*

In April 1974, a trial was carried out with the Finnish icebreaker APU to measure the resistance of ships in ice ridges in the Baltic Sea. Most of the 11 ridges encountered were so massive that they had to be rammed. When the ship was penetrating a ridge, resistance was determined by registering propeller revolutions and speed, the latter by means of a Doppler radar. When the ship was stopped by a ridge, she was extricated by reversing and accelerating for another ram. Time history was registered to determine speed of advance. The APU is one of the nine Baltic icebreakers operated by the Finnish Board of Navigation for assisting merchant ships to and from the Finnish ports.

Acknowledgement: BSRA

Available from: See Introduction "Availability of documents" Item (b)

11 0458

Maksutov, D.D. (1973). **Resistance to the motion of transport vessels in solid ice**. *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 31-39. (See entry no. 11 0438)*

Available from: See entry no. 11 0438

11 0459

Mantovani, S. and S. Valeri. (1978). **Mechanical behavior at ice-metal interfaces**. *Philosophical Magazine 37 pt.A (January): 17-26.*

Available from: See Introduction "Availability of documents" Item (b)

11 0460

Marine structures and ships in ice. *Project start date: 1978. Termination date: 1980. Performing Organization: Norske Veritas Research Division; River and Harbor Laboratory P.O. Box 300 Hovik N-1322 Norway, Klaebuveien 153 7034 Trondheim NTH Norway.*

Purpose: To develop computational methods and experimental techniques to predict the ice loads on ships and marine structures intended for arctic and subarctic waters. To acquire information about ice characteristics and environmental conditions in these areas. Benefits: The project is expected to provide adequate information about loads and environmental conditions in connection with design and evaluation of the safety of structures exposed. Activities: The following theoretical and experimental studies will be carried out: Collection of ice and environmental data for the Arctic. Evaluation of the mechanical properties of ice during short and long term load cycles. Investigation of local and global ice loads on ships and marine structures. Prediction of the resistance of ships in level ice. Study of loads on screws and rudder during interaction with ice. Investigation of ice-induced structural vibration. Evaluation of facilities (mechanical and pneumatic devices) in order to reduce the resistance and loads in ice. Survey of possible transport, terminal and offshore loading systems for arctic conditions. Development of ice modelling techniques. Model testing of ships and different offshore structures for prediction of loads and resistance in level ice and ridges. Investigation of the physical nature of icing and means to reduce the rate of icing. Evaluation of "optimum" form (shape) of structures in order to minimize the loads and resistance in ice. Design case, for illustration of the use of available methods and information provided through MSSI. At the end of 1980 an Ice Seminar will be held where the work and results of the MSSI project will be presented. Marine Structures and Ships in Ice (MSSI) is a joint research project sponsored by Scandinavian industry and institutions.

Acknowledgeemnt: MRIS

Available from: See Introduction "Availability of documents" Item (a)

11 0461

Marsh, G.D., R.W. Gulick and S.J. Calabrese. (1978). **The operating and maintenance benefits of abrasion resistant low friction hull coatings**. *In Offshore Technology Conference, 10th, Houston, Texas, May 8-11, 1978: papers, vol. 2, pp. 939-948.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0462

Menon, B. and P. Noble. (1979). **Ice impact loads on steering system components of Arctic Class ships**. *In Proceedings of the 5th International Conference on Port and Ocean Engineering under Arctic Conditions, Trondheim, Norway, August 13-18, 1979, vol. 2, pp. 1041-1068. Trondheim, Norway: The University.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0463

Mentz, P.B. (1974). **Improving ship operations in ice covered waters**. *Marine Technology Society Journal 8(1): 54-57.*

Available from: See Introduction "Availability of documents" Item (b)

11 0464

Michel, B. and D. Beranger. (1975). **Algorithm for accelerated growth of ice in a ship's track**. *In Proceedings of the International symposium on Ice Problems, 3rd, Hanover, New Hampshire, August 18-21, 1975, pp. 127-132. [S.l.]: International Association of Hydraulic Research, 1975.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0465

Milano, V.R. (1973). **Ship resistance to continuous motion in ice**. *In Transactions of the Society of Naval Architects and Marine Engineers Vol. 81: 274-306.*

Available from: See Introduction "Availability of documents" Item (b)

11 0466

Milano, V.R. (1975). **Ship resistance to continuous motion in mush ice**. *In Proceedings of the Ice Tech Symposium, Montreal, Canada, April 9-11, 1975, pp. B2/1-B2/32. New York, N.Y.: Society of Naval Architects and Marine Engineers, 1975.*

Many papers in the literature have addressed the problem of predicting resistance to ship motion in solid field ice. Very few have attempted to address the more practical problem of ship motion in brash or mush ice which often clogs the harbors of northern rivers and the Great Lakes. This is a much more difficult analytical problem and to date, has evaded practical solution. This paper presents an analytical approach to the solution of the problem of ship resistance to continuous motion in mush ice. It is patterned on the analytical model and methodology which was developed to treat the problem of solid field ice, but modified to reflect the peculiar characteristics of mush ice. The resulting analytical model is shown to generate results which correlate well with the limited existing test data on both conventional polar icebreakers and Great Lakes ore carriers with their extensive parallel middlebody. A computer program based on various ship and ice parameters is presented to facilitate problem solution.

Acknowledgement: SNAME

Available from: SNAME

11 0467

Milano, V.R. (1975). **Variation of ship/ice parameters on**

ship resistance to continuous motion in ice. *In Proceedings of the Ice Tech Symposium, Montreal, Canada, April 9-11, 1975, pp. B1/1-B1/26. New York, N.Y.: Society of Naval Architects and Marine Engineers, 1975.*

Over the years, many semi-empirical and analytical expressions have been developed to describe ship resistance to continuous motion in solid ice. In general, each of them has failed to give the ship designer any real qualitative appreciation of the effect of variation in ship and ice parameters on this resistance, and consequently were of limited value as a predictive design tool. This paper attempts to discuss the predictive capability of an analytical model for predicting ship resistance in solid ice which was developed by the author. In addition, it presents the results of a systematic variation of those various ship and ice parameters which effect this resistance in ice. Trend results due to variation of these parameters are developed and presented in graphical form so as to aid the ship designer appreciate their significance and influence on the total ship resistance in ice.

Acknowledgement: SNAME
Available from: SNAME

11 0468

Noble, P.G. et al. (1979). **Ice forces and accelerations on a Polar Class icebreaker**. *In Proceedings of the 5th International Conference on Port and Ocean Engineering under Arctic Conditions, Trondheim, Norway, August 13-18, 1979, vol. 2, pp. 1003-1022. Trondheim, Norway: The University.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0469

Noble, P. et al. (1980). **Polar class ice load and acceleration forecasts: final report**. *Kanata, Ontario: Arctec Canada Ltd. 2 vols. (Canada Ministry of Transport no. TP 2595)*

The report describes a study undertaken to estimate the ice loads and acceleration experienced by a polar icebreaker during its service life. The project included modifications of an existing math model of ship/ice interaction, and comparison of results from the math model with model and full scale data. The mathematical model predicted loads and accelerations which were interpreted as being in agreement with model and full scale data.

Available from: TDC Library, Montreal (Interlibrary loan)

11 0470

Paint protection for ice-going ships and ice-breakers. *(1975). Shipping World and Shipbuilder 168(3906): 535.*

Available from: See Introduction "Availability of documents" Item (b)

11 0471

Panov, V.V. et al. (1975). Naturnye ispytaniia kremniiorganoepoksidnogo pokrytiia na ryboprornyslovykh sudakh. **[Field testing of protective silicon-organic resin coatings on fishing vessels.]** *Leningrad. Arkticheskii i antarkticheskii nauchno-issledovatel'skii institut. Trudy, 1975 Vol. 317: p. 127-131. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0472

Peirce, T.H. (1979). **Arctic marine technology: a review of ship resistance in ice**. *Naval Architect 4(July): 219-235.*

The subject is arctic marine technology, the treatment is directed at the development and understanding of the various matters in relation to the North American scene. It must be acknowleded immediately, nevertheless, that the basic sciences and technology involved had their origin in Northern Europe and Russia where coexistence with ice and cold weather has long been a daily necessity of social, industrial and commercial life. The subject of arctic marine technology is an extremely wide one ranging from ships to many kinds of fixed and movable structures for use in ice-covered waters. An important aspect which is common to all of these many technologies is their interaction with the ice, either as a moving vehicle or as a stationary structure situated in a moving icefield. Much knowledge and experience of such interactions has been gained from the use of ships in ice and the underlying principles of ice resistance are addressed based upon ship technology under various arctic conditions.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

11 0473

Peschanskii, I.S. (1968). Potensial'naia soprotivliaemost' lediariogo pokrova: Novaia inzhenerno-geograficheskaia kharakteristika lediariogo pokrova. **[Potential resistance of ice cover: a new geographic and engineering characteristic of ice.]** *Trudy koordinatsionnykh soveshchanii po gidrotekhnike, 1968 Vol. 42. 51-56. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0474

Peter, J.J. and E.J. Lecourt. (1976). **Ice impact loads on the rudder of an icebreaking tug boat**. *Columbia, Md.: ARCTEC Inc. Final report. Report no. 201-C-1. 99 pp.*

During the winter of 1974-75 measurements were made of ice impact loads on the rudder of the USCGC NAUGATUCK during icebreaking maneuvers at Sault Ste. Marie, Michigan. The report shows the relative frequency versus magnitude of the rudderstock torque produced by ice impact in various maneuvers, including backing through pressure ridges. The results of similar tests conducted earlier on a sister ship are included. The measurements were made by strain gaging the rudderstock and by substituting specially designed pintles which were strain gaged to measure forces in orthogonal planes. The report explains the instrumentation system, the procedures used to gather the data, and the method by which the rudder was calibrated. Basic calculations of the rudder hydrodynamic loads are also presented.

Acknowledgement: NTIS
Available from: NTIS: cite AD-A021 770/3ST
Price: $8.00 U.S.

11 0475

Petrov, E. IU. (1967). **Determination of the hull emersion of an icebreaker forcing through heavy ice**. *Problemy Arktiki i Antarktiki 1967 No. 24: 68-72. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0476

Popov, IU. N. and V.I. Kashtelian. (1973). **Wedging of icebreakers in ice**. *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 68-81. (Translation).*

Available from: See entry no. 11 0438

11 0477

Popov, Yu N. et al. (1969). **Strength of ships sailing in ice**. *Washington, D.C.: U.S. Army Foreign Science and Technology Center. Report no. FSTC-HT-23-96-68. 232 pp. (Translation).*

Questions concerned with the theory and calculation of the strength of

hull structures of ships sailing in ice are considered. A method for determining the ice loads which act on a ship's hull as a result of navigation conditions, ice strength and characteristics, ship's hull lines, displacement, and speed in the ice, is presented. Basic methods for calculating internal stresses occurring the hull structure elements as a result of ice loads are presented. Questions concerned with rational designs for these structures are considered. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-684 596
Price: $14.00 U.S.

11 0478

Riska, K. and P. Varsta. (1977). **State-of-art review of basic ice problems for a naval architect**. *Espoo, Finland: Technical Research Centre of Finland, Espoo, Ship Lab. Report no. VTT-SL-2. 74 pp.*

The structure of ice and the initial formation of ice cover are described. The occurrence and classification of ice in the Baltic are reviewed. The mechanical properties of ice, from the viewpoint of a naval architect, are examined from both theoretical and experimental standpoints. The problems of ice-going ships are studied and modeling techniques for ice-breaking and ice cover are discussed.

Acknowledgement: NTIS
Available from: NTIS: cite N79-11257/9ST
Price: $7.00 U.S.

11 0479

Robinson, D.W. (1980). **Strength requirements for operating Great Lakes type bulk carriers in the Gulf Corridor to specific dates**. *Montreal, Quebec: Lloyds Register of Shipping. approx. 80 pp. (Canada. Ministry of Transport, No. TP 2618)*

This report contains analysis, comment and recommendations concerning strength requirements for existing Great Lakes type bulk carriers if they were to operate a service to Canso, Nova Scotia to specified dates within the full Great Lakes season. It is based on monthly wave data produced by the Department of Public Works, Ottawa, and the vessel's likely lifetime responses to these data.

Wave-induced loads affecting longitudinal and local strength are assessed, and recommendations for ships strengthening are given for the proposed service and for varying periods of exposure. Additionally, conditions of assignment for freeboard are investigated for the specified services.

Available from: TDC Library, Montreal (Interlibrary loan)

11 0480

Robinson, D.W. et al. (1978). **Investigation of strength aspects for the extension of service of Great Lakes type bulk carriers to the Gulf corridor for the full Great Lakes season**. *London, England: Lloyds Register of Shipping. 1 vol. (Canada. Ministry of Transport No. TP 1813)*

This report contains details of an investigation carried out by Lloyd's Register of Shipping to assess the strength requirements necessary for Great Lakes Type Bulk Carriers to operate safely through a defined "Gulf Corridor" to Canso, Nova Scotia.

The report contains a comparative analysis based on wave data produced by the Department of Public Works, Ottawa, for two areas of operation considered to be representative to the present and proposed services. The wave data is analysed and represented statistically so that "lifetime" wave induced design responses can be calculated for the proposed services to compare with those for the present service.

Still water and wave induced loads affecting longitudinal, transverse and local strength, are assessed, and recommendations for strengthening, are given for the proposed services.

Available from: TDC Library, Montreal (Interlibrary loan)

11 0481

Romanov, A.A. (1973). **Rezul'taty nabliudenii za ledoprokhodimost'iu sudov. [Observation data on the speed of ship movement in ice-covered sea.]** *Sovetskaia antarkticheskaia ekspeditsiia, Trudy. 1973 (No. 59): 86-94. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0482

Roos, A. et al. (1976). **Great Lakes ore carrier series ice resistance model test program: method for predicting level ice resistance of ships with main dimensions typical for the Great Lakes bulk carriers**. *Helsinki, Finalnd: Wartsila Ice-breaking Model Basin. Report no. WIMB-Test-41. 34 pp.*

This report contains a summary and conclusions from the ice breaking model tests of a systematic model series. The results of model tests are combined into one mathematical expression. With the expression it is possible to make ice resistance predictions for ships with different main dimension ratios and hull forms.

Acknowledgement: NTIS
Available from: NTIS: cite PB-266815/0ST

11 0483

Ryvlin, A.IA. (1973). **Experimental study of the friction of ice**. *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 217-234. (Translation). (See entry no. 11 0438)*

Available from: See entry no. 11 0438

11 0484

Sandakov, IU. (1974). Skorost' dvizheniia sudov v bitykh l'dakh. **[Speed of ship movement in broken ice.]** *Rechnoi transport, 1974 No. 2: p. 51. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

11 0485

Scarton, H.A. (1975). **On the role of bow friction in icebreaking**. *Journal of Ship Research 19(1): 34-39.*

Available from: See Introduction "Availability of documents" Item (b)

11 0486

Schwarz, Joachim. (1977). **New developments in modeling ice problems**. *In Proceedings of the 4th International Conference on Port and Ocean Engineering under Arctic Conditions, Memorial University of Newfoundland, St. John's, Nfld., September 26-30, 1977, v. 1, pp. 45-62. St. John's, Nfld.: The University, Ocean Engineering Information Centre, 1978.*

The occurrence of several different equations for predicting icebreaker resistance is due to the lack of theoretical approaches, incomplete physical understanding of the icebreaking phenomena, disregard of fundamental similarity laws, in case of model tests, and inadequate testing methods in full scale. In case of full scale tests, the obtained data scatter so widely that they easily can be used to prove different prediction equations. There are several reasons for the scattering of full scale data. In order to elucidate the fundamental relationship of parameters involved in icebreaking, a research project has been carried out at HSVA in which the different components of resistance have been analyzed separately by model tests on a simple body such as an inclined plane plate. The results show that the resistance of an icebreaking body is governed by simple physical relationships. As a consequence of these investigations, a new icebreaking concept has been developed, which breaks the ice cover mainly by shear and provides an icefree channel.

Acknowledgement: Engineering Index

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0487

*Segal, Z. and B. Levit. (1972). Ledoprokhodimost' rechnykh ledokolov. [**Speed of icebreaker in ice-covered rivers.**] Rechnoi transport, 1972 No. 1: p. 47. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

11 0488

*Shamkin, L.A. (1978). Izmerenie skorosti sudna pri plavanii vo l'dakh. [**Measuring ship velocity during ice navigation.**] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1978 Vol. 234: 36-43. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0489

Smirnov, V.I. (1979). **Effect of physicomechanical properties and uneven thickness of ice on the motion of ships in the autumn-winter season.** *Problems of the Arctic and Antarctic, collection of articles, 1979 Vol. 46: pp. 106-112.*

On the basis of the results obtained it can be tentatively concluded that for strong consolidated winter pack ice 40-100 cm thick a change in the unevenness of distribution of ice thickness from 0 to 1-2 points does not substantially affect the speed of powerful icebreakers. Consequently, for standard deviations of ice thicknesses up to +-0.10-0.15 m, for ratios of the greatest to the smallest thicknesses up to 1.4 and for hummocking of ice of less than 2 points a consolidated pack ice cover can be considered relatively level for navigational purposes. With any increase in the uneveness of distribution of ice thickness, for every point above 2 the speed of the icebreaker decreases by 15-35%. (Author)

Acknowledgement: ASTIS

Available from: See Introduction "Availability of documents" Item (b)

11 0490

Sneck, H.J. and J.M. Kaufmann. (1976). **Low friction hull coatings for icebreakers: phase II, part III — analysis of icebreaking in particulate ice.** *Troy, N.Y.: Rensselaer Polytechnic Inst. Technical report June 74-Oct. 75. 52 pp.*

In this portion of the Low Friction Hull Coatings project (Part III of Phase II), the resistance of ships moving through particulate (slush or mush) ice was studied. The purpose was to better understand the effect of friction in icebreaking. A mathematical model was derived for drag in ice concentrations less than 50%. Laboratory model tests were performed for concentrations greater than 50% in order to better understand the problem. A math model for resistance in high concentration ice was started but additional analytical and ice property research is needed to derive meaningful results. (Author)

Acknowledgement: NTIS

Available from: STIS: cite AD-A024 898/9ST

Price: $7.00 U.S.

11 0491

Steinert, H. (1978). **LNG through the North-West Passage: German technological preparations for the Arctic.** *Northern Offshore 7(4); 29-30.*

Plans to transport LNG from the west side of the Arctic archipelago to the eastern coast of America require further knowledge of ice technology. Efforts of the Federal Republic of Germany to develop large LNG tankers with ice breaking capabilities are described. The Hamburg Shipbuilding Experimental Station (HSVA) and a coordinate institute in Leningrad put into service the 1st ice testing basin for ship development. As of April 1978, no consistent observations were available regarding the relationship between a ship's speed and ice thickness where ice breaking is concerned. The properties of sea ice are discussed and evaluated. In the spring of 1977, a Russian icebreaking supply ship, Werrator, was sent on a 4-mo experimental voyage to Spitzbergen. Along with a bow thruster and twin screw variable pitch propellers, a jet mantle proved to be the decisive factor in the ice breaking process. The jet mantle protects the propellar blades from ice damage. Another important factor was the Jastram-HSVA air-water nozzle that was tested on the Werrator trip. From the bow of the ship a jet of water mixed with air is directed aft at about the waterline level, and with such force that it increases propulsion power and ice breaking capability by 20%. The air/water nozzle device is compared to a unit using only compressed air as a shield and is more efficient overall. Other tests conducted that involved basic research in ice technology are discussed. Once they are completely evaluated, they should provide much information as to the best construction of LNG tankers destined to travel through the North-West Passage.

Acknowledgement: Oceanic Abstracts

Available from: See Introduction "Availability of documents" Item (b)

11 0492

Teeson, D.H. (1971). **Corrosion protection for steel surfaces exposed to moving sea ice.** *In Proceedings of the 1st International Conference on Port and Ocean Engineering under Arctic Conditions, Trondheim, Norway, August 23-30, 1971, vol. 2, pp. 948-964. Trondheim: Technical University of Norway.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0493

*Tronin, V.A. and IU.A. Sandakov. (1970). Vybor tipa transportnogo sudna dlia plavaniia vo l'dakh. [**Selecting the type of a transport vessel for ice navigation.**] Opyt provodki rechnykh sudov v ledovykh usloviiakh (Experience in ice navigation of river vessels), p. 6-9. Moscow. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (a) and (d)

11 0494

Tusima, K. and T. Tabata. (1979). **Friction measurements of sea ice on flat plates of metals, plastics and coatings.** *In Proceedings of the 5th International Conference on Port and Ocean Engineering under Arctic Conditions, Trodheim, Norway, August 13-18, 1979, pp. 741-755. Trondheim, Norway: The University.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

11 0495

Tuukkanen, K. and H. Tallgren. (1978). **Recent experience of bottom protection on ice-going vessels.** *In International Ship Painting and Corrosion Conference and Exhibition, 3rd, Monte Carlo, 1978. 4 pp.*

The Authors, of Teknos Maalit Oy, give some general information on friction between ice and the hull of an ice-going ship, discuss ice-resistant coatings, and present a number of full-scale results which demonstrate the performance of their Company's Inerta 160, a solvent-free ice-resistant epoxy hull-coating.

Acknowledgement: BSRA

Available from: BSRA: cite no. 51,650 or see Introduction "Availability of documents" Items (a) and (b)

11 0496

Vance, George P. (1980). **Evaluation of ice deflectors on the USCG icebreaker POLAR STAR.** *Hanover, N.H.: Cold Regions Research and Engineering Lab. Special report. Report no. CRREL-SR-80-4. 42 pp.*

Model tests were carried out in the CRREL Ice Engineering Facility test basin on a 1 to 19.1 model of the USCG Polar Star (WAGB-10) to determine the effectiveness of several different devices that would eliminate or mitigate the ingestion of ice into the propeller slip stream. Propeller RPM records and high-speed movies were obtained for each device in two thicknesses of ice and at two speeds. Four devices were evaluated: large bilge keels, small bilge keels, bossing fins and propeller cages (called bird cages). The most effective concept appeared to be the bilge keels. Open water power tests and structural analysis must now be carried out to determine the overall feasibility of these concepts. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-A082 205/6
Price: $6.00 U.S.

11 0497

*Vitko, N.A. (1971). Opyt rascheta prokhodimosti ledokolov v morskikh l'dakh. [***Calculating the passability of icebreakers through sea ice.***] Leningrad. Arkticheskii i antarkticheskii nauchno-issledovatel'skii institut. Trudy, 1971 Vol. 300: p. 210-212. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0498

Voelker, R.P. and G.H. Levine. (1972). **Methods to improve Great Lakes bulk carrier performance in mush ice fields and clogged channels.** *Columbia, Md.: ARCTEC Inc. Final report. 2 vols.*

The objective of this research program was to determine methods to improve the performance of Great Lakes bulk carriers in broken ice fields during the winter and spring seasons. Phase I was directed toward the development of realistic models of the actual ice conditions prevailing in the bottleneck areas and to the examination of the behavior of a model of an existing bulk carrier under these conditions. Phase 2 was directed at developing methods for reducing bulk carrier resistance in mush ice and clogged channels employing air bubbler systems, waterjet systems, detachable icebreaking type bow, detachable bow with two propellers, and detachable bow of special design. The results are presented in terms of full scale ship performance.

Acknowledgement: NTIS
Available from: NTIS: cite COM-73-10937-SET
Price: $14.50 U.S.

11 0499

*Voevodin, V.A. (1973). Ob effekte obrazovaniia ledianoi "podushki" pri dvizhenii ledokola v molodom osennem l'du. [***Effect of "ice pillow" formation with icebreakers moving through young autumn ice.***] Problemy Arktiki i Antarktiki Sbornik statei, 1973 (Vol. 42): 59-65. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0500

Voevodin, V.A. (1976). **On the effect of ice "cushion" formation during movement of an icebreaker in young ocean ice.** *Problems of the Arctic and Antarctic, collection of articles, 1976 Vol. 42: p. 74-83.*

Available from: See Introduction "Availability of documents" Item (b)

11 0501

*Voevodin, V.A. and V.I. Kashtelian. (1979). Vliianie szhatiia l'dov na zaklinivanie ledokolov. [***Ice cover contraction effect on icebreaker jamming.***] Leningrad. Arkticheskii i antarkticheskii nauchno-issledovatel'skii institut. Trudy, 1979 Vol. 363: 126-133. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0502

*Vozhakov, A.A. and B.N. Rasskazov. (1967). K voprosu vzaimodeistviia grebnogo vinta so l'dom. [***Interaction between ship's propellor and ice.***] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1967 Vol. 87: p. 34-36. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0503

Walker, J.M., and P.W. Penney. (1973). **Arctic sea-ice and maritime transport technology.** *Weather 28(9): 358-371.*

Available from: See Introduction "Availability of documents" Item (b)

11 0504

Ward, S.R. (1968). **Forces exerted by ice on ships.** *Journal of Ship Research 12(4): 302-312.*

Available from: See Introduction "Availability of documents" Item (b)

11 0505

Wieghardt, K. (1976). **On the significance of the main resistance components of icebreakers.** *Schiffstechnik 23(November): [n.p.]*

The operational performance of icebreakers is dependent on the resistance Re which is made up of three components: (I) a gravitational resistance component. (II) ice-breaking capability expressed as a function of ship's breadth, ice thickness and ice strength, and (III) a small velocity component. Of these, the gravitational resistance component is the most important. The paper reviews theoretical work and model tests for calculating the resistance of icebreakers and explains how the failure to take account of a horizontal "earth pressure" due to the presence of ice floes has led to erroneous results. An improved model testing technique making use of a polystyrene "sand" (grain size 1 mm) is outlined and some results of resistance tests with a vertical plate are discussed.

Acknowledgement: BSRA
Available from: CISTI (Photocopying service)

11 0506

Yakonovskiy, S.V. and A.N. Smirnov. (1968). **Effect of geometric and kinematic parameters of a screw propellor on the value of external forces acting on an icebreaker during collision with ice.** *Tsentral'nyy n.i.i. Rechnogo Flota, Trudy Vol. 93: 38-55. (In Russian.)*

Effect of geometric and kinematic parameters of a screw propeller on the value of external forces acting upon an icebreaker during collision with ice. Compares values calculated on a computer for three geometrically different contours of blades under various conditions of motion of an icebreaker and rotation of its screw propeller. Shape of blade has a considerable effect on both the quantitative and qualitative changes in

curves for external impact forces. Quantitative estimates of the components of moments of external impact forces are given.

Acknowledgement: MRIS
Available from: Library of Congress Photoduplication Service Washington D.C. 20540 See also Introduction "Availability of documents" Item (d)

11 0507

Yakovlev, A.A. (1969). **Strength of ships sailing in ice.** *Washington, D.C.: U.S. Army Foreign Science and Technology Center. Translation no. FSTC-HT-23-96-68. 229 pp.*

Available from: NTIS: cite AD 684 596

11 0508

*Zakharov, IU.P., V.E. Malishevskii and B.N. Rasskazov. (1967). Sravnitel'naia otsenka raboty avtomatizirovannoi grebnoi elektricheskoi ustanovki ledokola s razlichnymi sistemami vozbuzhdeniia v rezhime vzaimodeistviia grebnogo vinta so l'dom. [***Comparative evaluation of the performance of an automatic propelling unit of an icebreaker with various starting systems, and the interaction of the propeller and ice.*** *] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1967 Vol. 76. p. 37-48. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

11 0690

United States. Coast Guard. (1980). **USCGC Glacier cruise report: Deep freeze 80.** *Long Beach, Cal.: U.S.C.G. 106 pp.*

The scientific mission during this deployment was primarily a marine geologic survey of the antarctic margin from 163W to cape Adare southward to McMurdo. An extensive survey of McMurdo Sound was included. Glacier's primary objective was to obtain data from those areas never before surveyed in order to connect with data obtained from previous cruises. The operational and logistics mission, in direct support of the resupply of McMurdo, consisted of escort service for the resupply vessels, facing the ice wharf, and towing out the ice wharf upon completion of the offloads.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Item (a)

11 0691

United States. Coast Guard. (1980). **USCGC Polar Sea cruise report: Deep freeze 80.** *Seattle, Washington: USCG. 96 pp.*

This report on the Coast Guard cutter Polar Sea's activities during Operation Deep Freeze 80 is divided into the following sections: ship operations; navigation; communications; science; engineering; administration; supply and logistics; medical; public relations; personnel; and recommendations.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Item (a)

11 0739

Albery, Pullerits, Dickson & Associates. (1977). **Arctic Terminal Concepts.**

The report discusses design considerations: ice loading, setdown requirements, mooring and loading arrangements and berm protection. Concepts discussed include underground storage, single point moorings, collapsible tanks, and both steel and concrete structures. Considerations of fabrication and transportation to site, and cost estimates are given.

Acknowledgement: Esso Resources Canada Ltd.
Available from: Imperial Oil Ltd.

11 0740

German & Milne Inc. (1978). **Arctic tanker study for Imperial Oil Ltd.**

The report is a transit analysis for the development of a small Beaufort oil field. Two routes, Eastern and Western are discussed in terms of ice conditions, capital cost, effect of ice class, fleet size and manoeuvring at a mooring island.

Acknowledgement: Esso Resources Canada Ltd.
Available from: Imperial Oil Ltd.

12 Vessels — Description and Design Information

12 0509

Achtarides, T.A. (1972). **Plastic design of plate panels for ice strengthening and slamming**. *New York, N.Y.: Society of Naval Architects and Marine Engineers. Paper presented at meeting of New England Section. 83 pp.*

An available elastic perfectly plastic analysis method which retains the influence of geometry changes is used for the design of panels for ice strengthening and slamming. Ice loads are determined using damage analysis data. Slamming loads are determined using available towing tank model test results, a theoretical relative velocity formulation, and design wave heights which are based on a uniform acceptable risk of damage for the lifetime of a ship. Results are compared with the ABS Rules and new design procedures are proposed. Recommendations are also made for further work in both areas.

Acknowledgement: SNAME
Available from: SNAME

12 0510

Adams, M.R. (1979). **Coast Guard breaks ice with new 140-foot tugs**. *United States Naval Institute Proceedings 105(912): 113.*

As part of its continuing efforts to modernize its fleets the United States Coast Guard recently took delivery of the first in a series of all-new 140-foot, medium harbour icebreaking tugs. Not only will the new class of vessels replace the older ships, its design is such that the ships should outperform the older vessels in all assigned missions: icebreaking, search and rescue, towing and marine environmental protection.

Acknowledgement: NSFI
Available from: See Introduction "Availability of documents" Item (b)

12 0511

Alexandrov, Y. (1979). **Russian Arctic Research**. *Canadian Shipping and Marine Engineering 51(2): 33-37.*

In 1979 the USSR launched a research ice-breaker to obtain data on the interaction between the ocean and the atmosphere, the Arctic climate, ice drifting, and the ice-breaking capacity of ships in high latitudes. The main operation area of the vessel will be a transitional zone between the free water surface and permanent ice fields; the ship can pass through ice fields < = 60 cm thick at = 2 kn. There are 14 laboratories on the ship. A vertical well passing through the body of the ship permits scientists to launch instruments and aqualung swimmers under the most severe conditions without leaving the ship interior. Instruments and winches on deck are protected by a special shelter. Hot air prevents the formation of an ice crust. The collection and processing of scientific information is highly automated. A satellite orientation system can determine the exact location of the ship; the computer center forecasts Arctic weather. To reduce pitching and rolling the ship has a special bow-shape, and damper cases were installed.

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

12 0512

*Arshenevskii, IU.A., and E.L. Shliss. (1974). Sudovoi dvizhitel'no-rulevoi kompleks. [***Ships' motive and steering complex for icebreaker**.] Soviet Inventions Illustrated Section 3 Mechanical and General. December 1975 W(47): No. 441192. Patent. (English abstract.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0513

*Asnin, B. (1974). Reidovyi buksir ledokol'nogo tipa. [***Ice breaking roadstead tugboat**.] Rechnoi transport, 1974 No. 7: p. 49-50. (In Russian.)*

Available from: CISTI (Photocopying Service See also Introduction "Availability of documents" Item (d)

12 0514

*Avferonok, E.I. et al. (1968). Issledovanie shuma v pomeshcheniiakh ledokolov. [***A study of noise in the compartments of icebreakers**.] Sudostroenie 58(1): 8-11. (In Russian.)*

The noise in the compartments of an icebreaker was studied to determine its nature and to find methods for reducing its intensity. The studies were conducted on the welded diesel-electric icebreaker Kiev; the noises in various compartments were recorded on magnetic tapes and were subjected to frequency analysis. For each octave, a histogram was constructed showing the density distribution vs the noise intensity in decibels. To indicate the irregularity of noise, two quantities were determined: the average noise level L(a) and the noise level L(0.1) which is exceeded in intensity less than 10 percent of the time. For machine noises, L(0.1)-L(a) = 1.5 db; for ice noises in the bow, this difference equals 6--10 db, indicating its irregular nature. Contours of the penetration into the ship by various frequency noises indicate that the higher frequencies penetrate deeper than the lower ones. As the ice thickness increases, the noise increases up to a maximum, and then decreases as the ship is slowed. In the bow, the acceptable noise was found to be exceeded by 10--20 db at all frequencies, even at some distance by 2--3 db at high frequencies. It is recommended that the noise must be reduced by 15--20 db at all frequencies.

Acknowledgement: MRIS
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

12 0515

Barber, B.H., L.M. Baez and G.J. North. (1975). **Structural considerations in the design of the "Polar" Class of Coast Guard icebreakers**. *New York, N.Y.: Society of Naval Architects and Marine Engineers. Paper presented at the Ship Structure Symposium, Washington, D.C., October 6-8, 1975.*

The design of the Coast Guard's POLAR Class icebreakers incorporated the results of four years of research, analysis and testing aimed at optimizing the structural design. Operation and load data were gathered by instrumenting existing icebreakers. Extensive tests and studies of available steels as well as a methodical analysis of reported structural failures were undertaken to assist in the selection of hull materials. Various finite element analyses were conducted for portions of existing and proposed structural arrangements with special emphasis on the

forward structure. With the cooperation of other agencies, studies of the strength of sea ice led to updated concepts of loading that resulted in significant changes in design philosophy and refinements over previous icebreaker designs.

Acknowledgement: SNAME
Available from: SNAME

12 0516

*Berdnikov, V. (1976). Tanker poliarnogo plavaniia. [***Tanker for polar waters.***] Morskoi flot, 1976 No. 5: p. 40-45. (In Russian.)*

A new Finnish-built tanker has joined the Soviet merchant fleet. It is designed for transporting oil, gas and other liquid cargo with a flash point of 28 C or higher through ice-bound seas. Its double hull and decks offer protection against explosion and fire, against ice damage, and provide insulation for the cargo. Thirteen similar ships are planned in the (Samotlor) series. Diagrams of the decks, the bridge, and the hull, as well as photographs of living quarters, officers' mess, engine room, and other facilities are included. The ship is intended for use in high-latitude waters of both hemispheres.

Acknowledgement: CRREL
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

12 0517

Beyer, Siegfried. (1979). **From "Yermak" to "Sibir".** *Washington, D.C.: U.S. Naval Intelligence Support Center. DDC no. AD B040 668L. 20 pp. (Translation).*

Available from: See Introduction "Availability of documents" Item (a)

12 0518

Bonz, P.E. (1973). **24 foot experimental river icebreaker development program.** *Rockville, Md.: Consultec Inc. 115 pp.*

Available from: See Introduction "Availability of documents" Item (a)

12 0519

*Botov, I. (1976). Atomokhody i ikh problemy. [***Atomic vessels and their problems.***] Morskoi flot, 1976 No. 1: p. 52-55. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

12 0520

Burke, I.T. (1972). **Central hydraulic system breaks the ice.** *Hydraulics & Pneumatics 25 (November 1972): 113-115.*

Available from: See Introduction "Availability of documents" item (b)

12 0521

*Burnazian, A. (1977). Atomnye ledokoly: radiatsionnaia bezopasnost' obespechena. [***Atomic icebreakers: safety from radiation guaranteed.***] Morskoi flot, 1977 No. 8: p. 41-43. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

12 0522

Bustard, E.E. (1973). **Merchant ships for the Canadian Arctic, Parts 1 and 2.** *Marine Engineers Review (November): 23-28; (December): 15-19.*

Available from: See Introduction "Availability of documents" Item (b)

12 0523

Bustard, E.E. (1975). **Importance of size in an Arctic ship.** *In Proceedings of the Ice Tech Symposium, Montreal, Canada, April 9-11, 1975, pp. F1-F7. New York, N.Y.: Society of Naval Architects and Marine Engineers, 1975.*

The purpose of this paper is not to put forward a detailed treatment of the subject but merely to demonstrate through a few crude models that the small ship has no useful function to fulfill in the Canadian Arctic during the ice bound season which extends over the greater part of the year. The assumptions may be criticized but to use a Newcastle expression "they are near enough for colliery work". Refinements may move the limits up or down a notch but the main conclusions are difficult to ignore. "Manhattan" was underpowered and barely large enough for Zone 6 (Eastern N.W. Passage) and for Zone 2 (Western N.W. Passage) she would be too small for commercial use as a bulk carrier whatever the power installed. Similar considerations apply to icebreakers, though since they are not required to carry a significant useful playload their limits will be at a somewhat lower displacement. In such ships, unless nuclear plants are employed, piling in power is not a useful solution. The fuel requirements for the increased power severely restrict radius of action. And, if the operational range is a design requirement, as it must be, more power means more fuel and hence increased displacement. Thus in all cases there is a lower limit on practical size which, if not provided, may produce a ship of inferior performance irrespective of the technical expertise employed. Consideration of ridge breaking ability demands even larger displacements and this is readily demonstrated by application of the simple laws of mechanics in relation to known experience. No indication is given as to what size should be adopted since every case will have to be considered on its merits in relation to ice capability required and radius and zone of action. Although much basic data is lacking an indication of important considerations in screening out ships which are impractically small for the duty required is given.

Acknowledgement: SNAME
Available from: SNAME

12 0524

Canadian-built ice-breaking bulk-carrier Arctic. *(1978). Shipbuilding and Marine Engineering International 101(1222): 478-485.*

Built by Port Weller Dry Docks, St. Catherines, Ontario, at a cost of $38 million for Canartic Shipping Company Ltd., the Arctic operates without icebreaker support in Zone 6 North Canadian waters for 4-6 mo/yr. It carries Pb-Zn ore concentrates from N of Baffin Island and other bulk products from other ports to Europe. The ship travels 3-4 kn through ice No 6 m thick (Arctic Class 2 or 2 ft) and can break thicker ice by ramming with an ice knife. The shell of the hull is from 54 to 25 mm thick in the ice belt and 15 mm thick clear of the ice belt. To meet pollution regulations an inner skin is used; the side tanks thus formed are used for water ballast only. Principal particulars include: overall length, 209.55 m; molded breadth, 22.86 m, colded depth, 15.24 m; extreme summer draft, 10.93 m; cubic cargo (with hatches), 36.050 m^3;power, 14,770 BHP; and speed, 15.5 kn. Arctic Calss 2 regulations governed the design and construction. Heavy longitudinal deck stiffeners and transverse beams were connected by electro-slag welding through holes drilled in the deck above. Equipment includes 4 Hydraulik Brattvaag hydraulic deck cranes of 20-ton hook capacity. Emphasis is on crew comfort during remote service. The engine is a MAN 14V52/55A with a maximum continuous rating of 14,770 BHP(m) at 450 rpm. The gears are especially proportioned to operate in ice. Navigation in ice is abetted by a 1,200 kW Waertsilae air-bubbler system. Other machinery and equipment are also described.

Acknowledgement: Ocean Abstracts
Available from: See Introduction "Availability of documents" Item (b)

12 0525

Carstens, T. and R.C. Byrd. (1975). **Oscillating icebreaking platform.** *In Proceedings of the International Symposium on Ice Problems, 3rd, Hanover, New Hampshire, August 18-21, 1975, pp.357-359. [S.l.]: International Association of Hydraulic Research, 1975.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

12 0526

*Chernikhovskii, G. (1973). Vibroledokoly poshli v delo. [***Vibro-icebreakers.***] Izobretatel' i ratsionalizator, Sept. 1973-No.9:p.32. (In Russian.)*

Availalbe from: See Introduction "Availability of documents" Items (b) and (d)

12 0527

Colburn, John W. Jr. (1973). **Development of an explosive icebreaker.** *San Antonio, Texas: Southwest Research Institute. Final report 6 Oct. 71-24 Mar. 72. 64pp.*

The report summarizes the development of SUB-ICE (Submerged Ice Cracking Engine). The testing of an experimental ice fracturing device and the theory and design of operational SUB-ICE systems are described.

Acknowledgement: NTIS
Available from: NTIS: cite AD-762 211
Price: $7.00 U.S.

12 0528

Decker, James L. (1978). **The application of air cushion configurations to icebreaking.** *Washington, D.C.: Office of Commercial Development. Report no. 110. 208pp.*

The objective of the project was the quantitative evaluation of the cost and effectiveness of air cushion configurations in icebreaking applications with displacement ships in level ice fields. Simple theoretical methods were developed for the prediction of the air cushion icebreaking capability in the low speed and high speed icebreaking modes. Conceptual designs for air cushion icebows and air cushion icebreakers were prepared and the economic analysis of their use with the displacement ships is reported. The self propelled air cushion icebreaker was determined to provide more flexible operational capability and was more cost effective for the cases examined.

Acknowledgement: NTIS
Available from: NTIS: cite PB-284 011/4ST
Price: $13.00 U.S.

12 0529

Dick, R.A., V. Laskow and J. Wainwright. (1980). **Design options for an Arctic-class LNG carrier.** *Ship building and Marine Engineering International 103 (April): 133-136*

Available from: See Introduction "Availability of documents" Item (b)

12 0530

Duval, B.C., J.L. Corgnet and J.J. Duval. (1976). **Explotary drilling on the Canadian Continental Shelf, Labrador Sea.** *Journal of Petroleum Technology 28 (April): 372-378.*

Success in drilling three exploration wells with the drillship "Pelican" is described. The dynamically positioned vessel has large storage capacity space for operation in remote areas, high drilling efficiency, and a capability of quickly disconnecting and reconnecting to the well in emergencies. Experiences with adverse weather and icebergs during the 1973-1974 campaigns and the 1971 experience with another ship are related.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

12 0531

Elsner, R., J. Dermody and J. Leiby. (1977). **Polar research vessel, a conceptual design for National Science Foundation, Office of Oceanographic Facilities and Support and Division of Polar Programs.** *Fairbanks, Alaska: Alaska University, 1977.*

The study... includes an analysis of the needs and prospects for polar research vessels, data on performance requirements (priorities, design features, and operational capabilities), and a summary of design decisions (bow, stern, and mid-body shape, icebreaking and ramming ability, propeller and rudder configurations, machinery, hull structure, weight, stabilization, cost estimates, and pollution prevention). A number of drawings and graphs on general ship arrangement, inboard profile, outboard profile, icing stability, shell plate, and construction are presented.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (a)

12 0532

Finland's ice ship ['Jarvsaar']. *(1979). Fishing News International 18 (May): 14-15.*

Available from: See Introduction "Availability of documents" Item (b)

12 0533

Finnlines' latest trailership. *(1969). Shipbuilding and Shipping Record 114(23): 35,38.*

The all season Baltic freight ferry Finncarrier is a 5500 grt four-decked vessel, fully ice strengthened and with an icebreaker bow, capable of carrying some 284 20-ft standard pallets, together with 160 private cars. Accomodation is provided for 36 passengers, including truck drivers. Twin screws are fitted to the two diesel engines developing 11,600 hp (metric) and a large protected semibalanced rudder will aid low speed maneuverability. Astern of the icebreaker bow there is a friction reducing arrangement known as the Dual Mixed Flow System. On either side of the bow, well below the waterline there are 15 openings of 30 cm in diam. Air is forced out of these openings at atm so that a cushion of air is formed between the hull and the ice. Details are given for cargo handling, machinery and special terminal facilities.

Acknowledgement: Engineering Index
Available from: TC Library Ottawa (Photocopying service)

12 0534

Freitas, A. and J. Schwarz. (1978). **New icebreaking concept.** *In Proceedings of the 5th I A H R Symposium on Ice Problems, Lulea, Sweden, August 7-9, 1978, v. 1. pp. 293-317. Delft, Netherlands: International Association for Hydraulic Research, 1978.*

A new type of icebreaker, based on a concept by H. Waas, has been developed and tested. The new technique aims at the elimination or reduction of the factors contributing to ice resistance. This is achieved by fracturing the ice through shear stressing rather than by bending and by creating an ice-free channel. The main features of the concept are a pontoon-shaped bow wider than the beam of the vessel, the V-shaped bottom of the forebody after the pontoon bow and an auxiliary mechanical propulsion system installed in the foreship. The special characteristics and the high performance of the WAAS icebreaker have been established in a series of tests carried out in an ice model basin.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Items (a) and (b)

12 0535

Gedraitis, V.N., V.K. Klimov and M.N. Nikitin. (1974). **Ice-protector for ship's rudder and propeller unit**. *Soviet Inventions Illustrated Section 3 Mechanical and General 1974-V(20): p. T6. Patent. (English abstract.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0536

German, J.G., C.F. Collins, and A.R. Webster (1972). **Some considerations in the design of polar icebreakers**. *Marine Technology 9(1): 42-58.*

Available from: See Introduction "Availability of documents" Item (b)

12 0537

German, J.G. and N. Dadachanji. (1975). **Hull forms for Arctic bulk cargo transportation**. *Paper presented at Society of Naval Architects and Marine Engineers 1975 Spring Meeting.*

Up to the present time the history of marine transport development in Arctic regions will show that we are still some distance upstream from the building and operation of a bulk carrier design for any but the most moderate of Arctic conditions. Research and development into the design and development of such vessels have been spotty and it has not yet been proven, despite the MANHATTAN program, that year-round bulk carrier operation in the high Arctic would be economically viable. The basic requirements of a commercial bulk carrier operating in the Arctic are technical and economical feasibility — as for such a vessel operating anywhere else. The economic feasibility depends on the ability to plan and estimate a successful operation which in turn hinges on just one factor — predictability. The main difficulty in achieving a reasonably predictable operation in the Arctic is simply the presence of ice in all of its many forms. Obviously ice will have a direct bearing on hull form design. This paper reviews these implications and discusses the problem in the light of hte results of investigations, tests, theoretical analyses and operating experience to date.

Acknowledgement: SNAME
Available from: SNAME

12 0538

German, W.H. (1977). **LNG icebreaker carrier requirements**. *In Proceedings of the Seminar on Natural Gas from the Arctic by Marine Mode: A Preliminary Assessment, 21-23 February 1977, pp.57-81. Ottawa: Science Council of Canada and Atlantic Provinces Economic Council.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

12 0539

*Grishin, V. and V. Rastorguev. (1971). Novaia ledokol'naia pristavka. [***New ice-breaking attachment to ships***.] Rechnoi transport 1971-No.10: p.48-49. (In Russian.)*

Acknowledgement: CISTI (Photocopying service)
Available from: See Introduction "Availability of documents" Item (d)

12 0541

Hindle, W. (1977). **Icebreaking LNGCS-practical and possible**. *Marine Week (November): 17-18*

A study completed by TransCanada Pipelines of Canada has confirmed that the LNG icebreaking carrier is a practical mode of transport for the movement of natural gas in the high Arctic islands where the amount of the reserves will not support a pipeline. Since no icebreaking LNGCs have yet been constructed, preliminary research aimed at establishing the design of such a carrier, was a vital part of the study.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (b)

12 0542

Icebreakers: hybrid dooms Polar 7. *(1978). Canadian Shipping and Marine Engineering 49(6): 7.*

Available from: See Introduction "Availability of documents" Item (b)

12 0543

Ice-breaking drillship for Arctic exploration. *(1973). Ocean Industry 8(7): 30-36.*

A description is given of an icebreaking drillship which will be used for oil exploration in arctic sea areas. A totally new concept in icebreaking technology has been incorporated in the ship's design, and this Penumatically Induced Pitching System (PIPS) is fully explained. Other aspects of the ship's design, such as ecological essentials, government regulations, and crew and shipboard safety are included in the description.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (b)

12 0544

Icegoing drill ships. *(1979). Engineering (London) 219(11): 1460-1461.*

Rauma-Repola Oy, the Finnish forestry, shipbuilding and engineering group, is to build the world's first dynamically positioned icegoing drillships to a Dutch design for a Soviet customer. At present there are only two drilling units in the world capable of operating in Arctic areas: one is a rig of the Ocean Ranger type operating off Alaska; the other is under construction at Rauma-Repola's Mantyluoto works. The three drillships now on order will be constructed as independant units capable of operating unsupported for up to six months in Arctic conditions. The article discusses the ship design and its dynamic positioning system.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

12 0545

Ignat'ev, M.A. (1971). **Ice-breaker for channel clearing**. *Soviet Inventions Illustrated Section 3 Mechanical and General November 1971: p.E3. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0546

Johansson, B.M., J.M. Saarikangas and I. Waltzer. (1975). **16.2 MW Baltic icebreakers**. *New York, N.Y.: Society of Naval Architects and Marine Engineers. [n.p.].*

The need for icebreakers in the northernmost part of the Gulf of Bothnia as well as the economics of winter navigation are discussed in some detail. The preliminary design of the URHO-ATLE class of icebreakers as well as model tests in the ice are reviewed. Icebreaker specialities and environmental considerations are explained. The machinery and the DC-DC electrical transmission system are viewed.

Acknowledgement: SNAME
Available from: SNAME

12 0547

Kaetzel, D.M. (1971). **Principal design features of the new Coast Guard icebreaker**. *Naval Engineers Journal 83 (April 1971): 49-52.*

Available from: See Introduction "Availability of documents" Item (b)

12 0548

Kallipke, Fritz. (1972). **Marine transport with commercial ice vessels in Arctic regions**. *Translation.*

The succesful attempt in 1969 of the giant tanker MANHATTAN which was fortified against ice to make a return trip voyage in the Northwest

Passage, has not only let the questions of Polar Ice navigation with specially built cargo vessels for this purpose become especially pressing for Canada, USA and USSR which are immediately bordering on the Arctic but also Finland, Sweden, Norway, Denmark, Japan, England, and Germany. The report discusses the author's proposal for a system solution for such a surface vessel.

Acknowledgement: NTIS
Available from: NTIS: cite PB-219 200-T
Price: $5.00 U.S.

12 0549

Kallipke, F. (1973). **Icebreaking cargo vessel: a proposed new hull form.** *Shipping World and Shipbuilder 166(3880): 431-432.*

Available from: See Introduction "Availability of documents" Item (b)

12 0550

Kashtelyan, V.I. et al. (1973). **Icebreakers.** *Hanover, N.H.: Cold Regions Research and Engineering Lab. Report no. CRREL-TL-418. 269 pp. (Translation).*

The report describes the development and design of icebreakers, discusses methods of calculating their ice performance, design and arrangement features and points out paths toward further improvement. All present Soviet and foreign icebreakers are described, their operating conditions are analyzed, the basic ice performance characteristics of an icebreaker are examined (ice speed to power ratio, ice strength, maneuverability, jamming conditions), and methods of evaluating these qualities, developed by Soviet specialists, are set forth; the design features of the basic machinery and systems of icebreakers are noted; recommendations on their design are presented. A considerable part of the book is devoted to features of the choice of hull shape, main dimensions and power plant. Data on icebreakers hull design and relations for determining the strength dimensions of the framing and plating are presented. (Modified author abstract).

Acknowledgement: NTIS
Available from: NTIS: cite AD-767 457/5
Price: $20.50 U.S.

12 0551

Kohnen, H. (1972). **Glaciological investigations for the improvement of ice-going ship design carried out on the sea ice near Pond Inlet. N.W.T. (northern Baffin Island) in Spring, 1972.** *In Proceedings of the 3rd International Conference on Port and Ocean Engineering under Arctic Conditions, Fairbanks, Alaska, august 11-15, 1975, v. 1, pp. 315-331. Fairbanks: University of Alaska, 1976.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

12 0552

Kohnen, H. (1976). **Glaciological research relevant to the construction of ice-going ships.** *Ocean Engineering 1976 (3): 343-360.*

Available from: See Introduction "Availability of documents" Item (b)

12 0553

*Koval', G.M. (1973). Sostoianie i problemy sovremennogo ledokolostroeniia. [***Status and problems of modern icebreaker building.***] Sudostroenie July 1973 (no. 7): 3-13. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

12 0554

*Kudriashov, E. (1976). Podgotovka sudov k rabote v zimnikh usloviiakh. [***Preparing ships for ice navigation.***] Rechnoi transport, 1976 No. 2: p. 13. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

12 0555

Laker to have new bow for navigation in ice. *Globe & Mail. Report on Business 14 July 1977: B1.*

Available from: See Introduction "Availability of documents" Item (c)

12 0556

Laskey, N.V. (1976). **Designing a bulk carrier for the Canadian Arctic.** *Motor Ship 56 (March): 71-76.*

Available from: TC Library, Ottawa (Photocopying service)

12 0557

Legenk, M.G. (1974). **Stern for ice-fishing trawler.** *Soviet Inventions Illustrated Section 3 Mechanical and General October 1975-W(37): No. 441189. Patent. (English abstract.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0558

Legerer, F.J. (n.d.). **Design strategy for ice navigation.** *In Proceedings of the 2nd International Conference on Port and Ocean Engineering under Arctic Conditions, University of Iceland, [n.d.], pp. 101-114. St. John's, Nfld.: Memorial University of Newfoundland.*

Recently, increasing demands for navigation to ports which are ice-infested for some part of the year are mostly due to the economical desirability of exploiting natural resources of Arctic and Subarctic regions. For this particular and simple objective the formulation of design criteria will be attempted in the following: Consider sea transportation system between two points A and B; port A may be situated in a fiord, which is ice-infested for some part of the year, while destination point B may permit ice-free year round operation. A land fast ice cover is typical within such a fiord, while open sea-ice, i.e. more or less densily floating ice floes, normally prevail outside of the entrance to the fiord. The principal variable of the open sea ice is its extent, which changes with meteorologic conditions, mainly the wind direction. Hence, the problem has to be solved under the following constraints: (a) Maximum permissible draft in port A; (b) Distance from port A to Port B; (c) Length of fiord at A; (d) Properties of fast ice: time dependent statistical distribution of strength and thickness in the fiord. (e) Statistical distribution of the distances which have to be overcome under sea ice conditions.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Items (a) and (b)

12 0559

Lewis, J.W. (1973). **Design of a controlled depth, submerged barge and tug system for Arctic marine transportation.** *In Offshore Technology Conference, Houston, Texas, April 30 — May 2, 1973 vol. 1, pp. 743-756. Dallas, Texas: Offshore Technology Conference. Report no. OTC 1181.*

This paper describes the feasibility design of an Arctic marine, crude oil transportation system. The system consists of a depth controlled, submerged barge towed by a powerful, surface icebreaking tug. The design of the tug, barge, towing system, and control systems are described. Because the cargo is carried below the ice-water surface, the system is capable of achieving advance speeds through a given ice field which is greater than an equivalently powered conventional surface system. This

feature, when combined with total system costs, can represent a competitive economic advantage over alternative marine systems. The paper concludes that the system is technically feasible and that with a suitable development program, an operational system could be realized with present day technology.

Acknowledgement: MRIS
Available from: Offshore Technology Conference 6200 North Central Expressway Dallas, Texas 75206

12 0560

Liljestroem, G. (1979). **Arctic bulk carriers-general descriptions**. *Paper presented at the Symposium on Soviet-Swedish Scientific and Technical Cooperation in Shipbuilding, Gothenburg, November 19-23, 1979. Paper no. 2. 24 pp.*

The paper presents four designs of ice-strengthened vessels for arctic operation. These designs are: a 31,900 dwt ice-strengthened bulk carrier, a 37,000 dwt arctic bulk carrier, a 6500 dwt arctic multi-purpose ship and a 15,000 dwt arctic multi-purpose ship. The dimensions and capacities are listed and hull form, design, machinery as well as outfitting are discussed for each type of design. The feasibility of converting the 37,000 dwt bulk carrier into an arctic drilling support vessel is also discussed.

Acknowledgement: NSFI
Available from: NSFI: cite no. 19485

12 0561

McNally, R. (1975). **PIPS icebreaking system being tested**. *Petroleum Engineer International 47(1): 62.*

The PIPS concept of icebreaking, in which a ship's vertical bow motion is greatly amplified at its natural pitch frequency, has been extended into a second phase of development with virtual elimination of half of the original system's tanks and machinery. PIPS (pneumatically induced pitching system), as initially introduced by Arctic Engineers and Constructors, consisted of both bow and stern ballast tanks that were alternatively filled and emptied to maximize the downstroke force of the bow against the ice. The latest refinement, PIPS MK-II, consists of bow tanks only, with an above water line height about equal to the below water line depth of the discharge ports. Significant advantages over the previous configuration are listed.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

12 0562

Makeenko, V.I., V.S. Mal'tsev and V.V. Egorov. (1974). **Ice-clearing cutter**. *Soviet Inventions Illustrated Section 3 Mechanical and General 1974-U(51): p. U1. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0563

Malkov, I.E., A.S. Maniukov and A.V. Pyzhikov. (1974). **Shipping line ice breaking system**. *Soviet Inventions Illustrated Section 3 Mechanical and General 1974-V(13): p. U6-7. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0564

*Meier, E. (1974). Ustroistvo dlia uvelicheniia ledoprokhodimosti ledokola. [***Icebreaker bow heater jets.***] USSR. Komitet po delam izobretenii i otkrytii. Patent, March 30, 1974, 2 pp. For English abstract see Soviet inventions illustrated, Sec. 3: Mechanical, Oct. 1974, V(35), No. 404698.*

Available from: See Introduction "Availability of documents" Item (b)

12 0565

*Mohacsi, S. (1965). Kinetik von Eisbrechern mit Stampfanlagen. [***Kinetics of icebreakers with ramming capability.***] Schiff und Hafen 17(6): 461-466. (In German.)*

Discusses theoretic and mathematical aspects of the technique of ramming ice, including potential energy, dissipation and resonance functions. A new device patented by Hitzler for greatly improving the vessel's ramming capability is described and evaluated. The essence of the method is that additional momentum is added to the icebreaking force of the vessel by placing in its bow either an eccentrically rotating mass, whose maximum angular momentum is co-ordinated and synchronized with that of the striking icebreaker, or a hydraulic ram device which adds dynamically to the ice-breaking capability of the ship. Details of this invention are described in the German patent specifications 965899 of 1957, and 1,092,336 of 1961, and in British patent (London) 838,414 of 1960 from which illus, equations, etc are reproduced.

Acknowledgement: Arctic Institute of North America
Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

12 0566

*Moreinis, F.A. and L.G. Tsoi. (1977). Vybor osnovykh kharakteristik krupnotonnazhnykh transportnykh sudov aktivnogo ledovogo plavaniia. [***Selection of basic characteristics of large-capacity ice-navigating transport ships.***] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota, Trudy, 1977 Vol. 222: 65-75. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

12 0567

Morita, S. (1978). **Analysis of air cushion icebreaking devices attached to ships: summary report 1978**. *Downsview, Ontario: DeHavilland Aircraft of Canada Ltd. De Havilland Report no. ECS-78-5. 77 pp. (Canada. Ministry of Transport. No. TP 1773.)*

Available from: TDC Library, Montreal (Interlibrary loan)

12 0568

Morris, R.E. (1975). **Notes regarding marine engineering concepts for machinery of ice-capable ships and ice breakers**. *Marine Engineers Review (May): 38, 41-42.*

Availalbe from: See Introduction "Availability of documents" Item (b)

12 0569

New river "icebreaker" developed. *(1973). Marine Engineering/Log 78(10): 49.*

A new "icebreaker" for use in rivers and other navigable waters, and developed by the U.S. Coast Guard, is described. Its method of operation and degree of efficiency achieved in field tests are given. Field test results demonstrate that this mechanical ice cutter is a viable system for cutting and clearing a channel in ice.

Acknowledgemnt: MRIS
Available from: TC Library, Ottawa (Photocopying service)

12 0570

New-type icebreaking bow for Great Lakes bulk carriers. *(1977). Motor Ship 58(August): [n.p.]*

A 30,000-dwt Great Lakes bulk carrier being built by Collingwood Shipyards for Canada Steamship Lines has a new type of bow, developed by the builders, for breaking late and early-season ice in the Lakes and St. Lawrence Seaway. It had been found that the bluff bows of previous ships tended to push the ice ahead in the Seaway locks, so making an

extra locking-cycle necessary. The new box is V-shapped almost up to the load waterline, and then slopes back slightly to enable it to break the ice from underneath; above the sloping section, the bow is flared to keep the deck dry and free from ice-forming spray in heavy weather. The bow, which should help to penetrate ice up to several inches thick, if of the same 26 mm mild steel as the bows of other Lakers, but more attention has been paid to panel and local strength. The ship, a self-unloader, has her hold lined with high-density polyethylene to keep her usual cargo of western Canadian coal free-flowing; cargo reclaimers, running above the conveyer belts, are provided to disturb the cargo and ensure positive feed. The new bow, in a refined form for higher speed, is also to be fitted to a similar ship intended for the Nova Scotia run.

Acknowledgement: BSRA
Available from: TC Library, Ottawa (Photocopying service)

12 0571

Nordenbrink, N.I. (1976). **Design of tugs for coastal and harbour icebreaking duty**. *Ship and Boat International 29(12): 45-46.*

This article is intended as a check-list for owners or consultants considering new designs for coastal and harbour icebreaking tugs. Among the points mentioned or briefly discussed are: choice of hull lines, ice-cutting blades and ice spurs; hull strengthening; cooling-water intakes; steering gear and rudder; cp propellers and overload protection; fitting of ice fins aft; adequate lighting (standby generator sets must start instantly); bridge layout and equipment; insulation from noise; adequacy of heating-boiler; range of "trimability", with tanks located away from danger of freezing; machinery air-intakes; safety of personnel walking on deck; bollards; and stability when the vessel is heavily iced.

Acknowledgement: BSRA
Available from: See Introduction "Availability of documents" Item (b)

12 0572

Nuclear ice-breaker "Arktika" *[translation from Russian]. (1976). Light Steam Power 25 (Oct.-Dec.): 205-209.*

Available from: See Introduction "Availability of documents" Item (b)

12 0573

Ol'shannikov, V.A. et al. (1975). **Ship's towing gear for icy conditions**. *Soviet Inventions Illustrated Section 3 Mechanical and General February 1975 V(52): no. 418372. Patent. (English abstract.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0574

Owaki, R. (1965). **Icebreaker FUJI**. *Washington, D.C.: U.S. Office of Naval Intelligence, Translation Section. O.N.I. Translation, Aug. 8, 1966 No. 2195, p. 1-8.*

The ice-resistant cargo ship (Soya) built in 1943 was replaced by a new icebreaker (Fuji). The two ships are compared for ship type, force, cargo carrying capacity, ocean observation facilities, reliability, safety, and accommodations. The (Fuji) is strongly built to withstand the stresses imposed by operating conditions in the Antarctic and is equipped with modern scientific instruments.

Acknowledgement: CRREL
Available from: See Introduction "Availability of documents" Item (a)

12 0575

Perrini, F. (1977). **Icebreaker capability reference document**. *Washington, D.C.: U.S. Coast Guard.*

Available from: See Introduction "Availability of documents" Item (a)

12 0576

Peschanskii, I.S. (1964). **Ice-cutting ships and high-pessure water jets for cutting ice**. *Ottawa, Ont.: Defence Research Board, Directorate of Physical Research. Report no. Misc. G-18. 2 pp. (Translation).*

The ice-cutting ship is a vessel equipped with a complex mechanism for cutting, breaking, and transporting the ice. It is designed to provide an open ice-free channel in fast ice for the passage and towing of ships. The special feature of the ice-cutting ship is that by its forward movement it cuts a strip of ice supported at one end (a cantilever beam) rather wider than the ship itself. The cutting may be achieved by means of mechanical cutters, high-pressure hydraulic jets, or other applied physical principles. Owing to the forward motion of the ship and the configuration of the bow, which slopes at an angle of 15 degrees to the sea surface, the ice strip is bent, reaches the critical point and breaks into pieces by its own weight. The ice-cutter has a number of advantages over the icebreaker. The advantages are as follows: (a) The ice-cutter forms a straight, even channel, wider than that cut by an ice-breaker; (b) The ice-cutter expends less energy on the whole operation cutting, breaking, and removing the ice than does the icebreaker. (c) The channel left by the ice-cutter remains clear and suitable for the passage of even the most thin-skinned ships. Thus the ice-cutter would make it possible; (a) to cut channels in sea and river bays for the passage of ships into ports in winter; (b) to cut fast ice and so allow earlier navigation in arctic seas; (c) to cut channels in the autumn and so extend the navigation season after the ice forms; (d) to cut channels in reservoirs in winter.

Acknowledgement: NTIS
Available from: NTIS: cite AD-613 202
Price: $5.00 U.S.

12 0577

A pioneering icebreaker/tug for Arctic development. *(1980). Motor Ship 60(716): 26-29.*

Built by Saint John Shipbuilding to a standard higher than Arctic class 3, the large icebreaker/anchor handling tug "Canmar Kigoriak" will help to evolve the designs of future vessels for arduous duties in the Canadian Arctic. Single-screw c.p. propulsion is by two Sulzer 12ZV40/48 medium-speed engines developing a total of 17,400 bhp. The vessel is built as an icebreaker/anchor-handling tug to operate in the Beaufort Sea and Western Arctic Ocean, primarily providing support services to drill ships, but also acting as a working laboratory for ice testing of the hull structure and propulsion train elements, the results of which will be used in future Arctic class vessels. Support services to drill ships will include: anchor handling and station moves, the supply of pipes, cement, specialised equipment, and consumable stores; in addition, the vessel is equipped with ship-to-ship fuel oil transfer and metering facilities. A further special requirement is the breaking up or deflection of large ice floes threatening to drive drill ships off station.

Acknowledgement: MRIS
Available from: TC Library, Ottawa (Photocopying service)

12 0578

Popov, IU.N., T.Kh. Tegkaeva and O.V. Faddeev. (1973). **Effects of the lines of an icebreaker on the magnitude of ice loads**. *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 89-99. (Translation).*

Available from: See entry no. 11 0438

12 0579

*Puzevskii, M. and N. Miasnikov. (1972). Ledokol'naia pristavka "LPS". [***Ice-breaking attachment "LPS"***.] Rechnoi transport, 1972 No. 2: p. 49-50. (In Russian.)*

Available from: CISTI (Photocopying service) See also Introduction "Availability of documents" Item (d)

12 0580

Rastorguev, V.V., A.M. Ter-Akopov and A.I. Begunkov. (1971). **Ice-breaker attachment**. *Soviet Inventions Illustrated Section 3 Mechanical and General November 1971: p. E11. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0581

*Ridderstrale, C.-E. (1974). Hoghallfasta stal for fartygsbygge. [***High strength steel for ship construction**.*] Styrelsen for Vintersjofartsforskning. Forskningsrapport, 1974 No. 7: p. 71-77. (In Swedish.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

12 0582

*Rozenberg, G.Sh. et al. (1977). Primenenie pnevmoomyvaiushchikh ustroistv'na ledokolakh i transportnykh sudakh ledovogo plavaniia. [***Pneumatic washing devices for icebreakers and ice navigation transport vessels**.*] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1977 Vol. 226: p. 28-36. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

12 0583

Ryvlin, A.Ya. (1967). **On the problem of streamlining the bow extremity of icebreaking transport ships**. *Problemy Arktiki i antarktiki 26: 108-109. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

12 0584

Sandnaes, P.C. (1975). **Icebreaking tanker designed for Arctic use**. *Oil and Gas Journal 73(48): 102-106.*

A semisubmarine icebreaking tanker design for all-year transport of crude oil in Arctic waters that permits steady passage through pack ice up to 12.5 ft thick is described. Developed by the Norwegian Aker Group after five years of research, the double-skinned, cargo-carrying hull is stable as a result of adding 40,000 tons of permanent ballast at the bottom and a dry compartment on the top. Bow of the cargo section is shaped for conventional icebreaking. Front edge of the forward transitional section slopes back to provide an ice-cutting edge when vessel is submerged.

Acknowledgement: Engineering Index

Available from: See Introduction "Availability of documents" Item (b)

12 0585

*Sarkisov, A.A. (1970). O bezopasnosti atomnykh sudov. [***Safety of atomic vessels**.*] Morskoi sbornik, Oct. 1970 No. 10: p. 66-71. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

12 0586

The semi-submersible ice breaking tanker. *(1976). Northern Offshore 5(2): 71-72.*

Available from: See Introduction "Availability of documents" Item (b)

12 0587

Serbul, G.IA. (1972). **Ship's ice-breaking attachment**. *Soviet Inventions Illustrated Section 3 Mechanical and General April 1972: p. E6. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0588

Ship for all seasons. *(1976). Canadian Shipping and Marine Engineering 47(4): 7.*

Available from: See Introduction "Availability of documents" Item (b)

12 0589

Shvaishtein, Z.I. (1973). **Ice-breakers for making ice-free channels**. *Problems of the Arctic and Antarctic Vol. 38: 170-175.*

The "ice-plows" described are special attachments for icebreakers and other vessels for cutting ice cover up to 2 m thick and through ice-blocks piled up to 7 m high.

Available from: See Introduction "Availability of documents" Item (b)

12 0590

Solostianskii, D.I. (1973). **On the calculation of the side shell plating for the effect of an ice load**. *In Ice navigation qualities of ships. CRREL Report no. TL-417, pp. 180-199. (Translation). (See entry no. 11 0438)*

Available from: See entry no. 11 0438

12 0591

"Stig": icebreaking tug. *(1976). Ship and Boat International 29 (December): 47-48.*

Available from: See Introduction "Availability of documents" Item (b)

12 0592

Thermal insulation of piping for Arctic expeditionary oil tanker. *(1970). Industrial Heating 37(4): 726, 728, 730.*

SS Manhattan was extensively overhauled in preparation for exploring a year-round route to connect Alaskan oil fields with U.S. East Coast. Tanker can carry 38 million gal of oil on 4500 mi voyage half of which involves arctic ice and temperatures of -50 F. Deck piping was insulated with Johns-Manville aluminum jacketed Metal-On insulation consisting of a vapor barrier and thermobestor. The main ship engines, numerous interior lines and heating and ventilating systems were also insulated.

Acknowledgement: Engineering Index

Available from: See Introduction "Availability of documents" Item (b)

12 0593

Thornburg, R.B. and K.M. Jones. (1975). **Mooring apparatus for ice-breaking drill ship**. *Washington, D.C.: U.S. Patent Office. Patent, June 3, 1975.*

Available from: See Introduction "Availability of documents" item (a)

12 0594

Trawling in Finland's winter with a new type of steel-hulled stern-fishing vessel. *(1979). World Fishing 28(12): 48-49.*

Designed and ordered by Erik Liljeberg in cooperation with Valmet's shipbuilding group Oy Laivateollisuus Ab, the Jaervsaar has an Ice Class 1A steel hull and a frame design allowing the trawl wires to be led directly under the ice. Trawl gear control is from the bridge. The crew works in safety and comfort below the covered deck. The stern location of the main engine-above the propeller shaft-permits 50-60% more cargo space. Principal particulars are included. The vessel was designed especially for winter fishing-the time of largest catches. The owner estimates a Jaervsaar-type of trawler can catch 1.5 million kg/yr. Finland's catches amount to < = 120 million kg annually and imported fish products = 120 million kg annually.

Acknowledgement: Ocean Abstracts
Available from: See Introduction "Availability of documents" Item (b)

12 0595

*Tsoi, L.G. (1977). Vybor energovooruzhennosti ledokola s uchetom vliianiia massy na ledoprokhodimost'. [***Selecting power-to-weight ratio for icebreakers allowing for the effect of mass on the speed of movement in ice-covered seas****.] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota, Trudy, 1977 Vo. 222: 120-124. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

12 0596

*Tsoi, L.G. and O.V. Faddeev. (1978). Vliianie trebovanii k prochnosti na vesovye kharakteristiki metallicheskogo korpusa transportnykh sudov ledovogo plavaniia. [***Strength requirements and the weight of metallic frames of transport ships navigating in ice****.] Leningrad. Tsentral'nyi nauchno-issledovatel'skii institut morskogo flota. Trudy, 1978 Vol. 232: 51-57. (In Russian.)*

Available from: See Introduction "Availability of documents" Items (b) and (d)

12 0597

Tsykin, E.N., IU.A. Arshenevskii and L.P. Grebennikov. (1973). **Ship's ice-cutting attachment**. *Soviet Inventions Illustrated Section 3 Mechanical and General February 1973: p. E4-E5. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0598

Tsykin, E.N., IU.A. Arshenevskii and L.P. Grebennikov. (1974). **Ship's hydraulic ice-cutter**. *Soviet Inventions Illustrated Section 3 Mechanical and General 1974-U(52): p. T2. Patent. (In English and Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0599

Turnbull, M.J. (1966). **Cathodic protection of ships operating in ice**. *Materials Protection 5(4): 44-45.*

Available from: See Introduction "Availability of documents" Item (b)

12 0600

Twenty-five-year-old icebreaker renewed in Helsinki. *(1979). Canadian shipping and Marine Engineering 51(2): 36-37.*

Available from: See Introduction "Availability of documents" Item (b)

12 0601

United States. General Accounting Office. (1979). **The 140-foot harbor tug boat: does the Coast Guard need it on the East Coast***? "PSAD-79-17". Washington: General Accounting Office. 15 pp. Acc. no. 79-13574.*

Available from: See Introduction "Availability of documents" Item (a)

12 0602

Vajravelu, P. (1977). **Force method of ship hull vibration analysis**. *International Shipbuilding Progress 24(274): 161-167.*

A force method of ship hull vibration analysis is presented. Analogies between the various quantities in the deformation method and force method were derived for longitudinal and vertical vibrations, so that existing programs working on the deformation method can be used. The main advantages of the force method are that the vibratory forces and moments are obtained directly without further numerical differentiation, and it is relatively easy to operate with nonsingular matrices in the eigenvalue problem. For an ice-going ship under an impact force and impact bending moment, the envelopes of the maximums of vibratory shear forces and bending moments are given; the former has 5 peaks while the latter, more affected by the impact, has only 3 peaks.

Acknowledgement: Oceanic Abstracts
Available from: See Introduction "Availability of documents" Item (b)

12 0603

Vetter, M.F. (1973). **Ice as a structural material in Arctic transportation**. *ASME paper no. 73-PET-36 for American Society of Mechanical Engineers meeting Sept. 16-20, 1973. 8 pp. New York: American Society of Mechanical Engineers.*

It is suggested that ice be frozen inside the double hull of an icebreaker-oil tanker in order to further strengthen and protect the hull while moving through ice-bound Arctic waters. Model tests were conducted to determine the strength increase (if any) achieved by freezing water within a double shell. Test results show a dramatic increase in model strength with the addition of an ice core. Observations are made on the significance of these results.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (a)

12 0604

Vinogradov, O.G., J.A.C. Kentfield and P.J. Vermeulen. (1979). **Icebreaking mechanisms for icebreakers and offshore structures**. *Proceedings of the 5th International conference on Port and Ocean Engineering under Arctic Conditions, Trondheim, Norway, August 13-18, 1979, vol. 2, pp. 1069-1079. Trondheim, Norway: The University.*

Available from: See Introduction "Availability of documents" Items (a) and (b)

12 0605

Voelker, R.P. (1971). **Ships to transit the Arctic Ocean**. *Columbia, Md.: ARCTEC Inc. 16 pp. Paper presented at the Symposium on Arctic Logistics Support Technology, Hershey, Pennsylvania, November 1-4, 1971.*

Within the next decade, ships will be crossing and supporting operations in the Arctic Ocean during all seasons. The specialized technology and engineering research laboratories are available today to achieve these goals. The purpose of this paper is to review the icebreaking ship design technology and to present a conceptual design for an icebreaking ship capable of breaking ten feet of ice in the continuous mode. Included in the discussion is a brief description of arctic ice conditions, the conceptual design of an icebreaking ship with a table of principal characteristics, and an estimate of ship cost. A description of some current engineering research efforts to reduce icebreaking resistance is presented including some thoughts on areas requiring further investigation.

Acknowledgement: MRIS
Available from: Arctec, Incorporated 9104 Red Branch Road Columbia, Maryland 21045

12 0606

Waring, Gerald. (1968). **The Alexbow ice plow**. *U.S. Naval Institute. Proceedings 94(11): 141-144.*

Available from: See Introduction "Availability of documents" Item (b)

12 0607

What's new in ship construction — retrofitting the Manhattan for the Arctic. *(1969). Ocean Industry 4(11): 71-73.*

Gives data on original and renovated features of the Manhattan icebreaker-tanker, citing 18 additions made for arctic testing and briefly describing nine specific projects, such as the bow, ice belt, welded doublers, ice horns, de-icing equipment, etc.

Acknowledgement: MRIS
Available from: See Introduction "Availability of documents" Item (b)

12 0608

White, R.M. (1970). **Prediction of icebreaker capability**. *Royal Institution of Naval Architects Quarterly Transactions 112(2): 225-251.*

An analysis for predicting icebreaker behavior is described for ramming, continuous operation, and for the difficulty of extraction. To improve ramming ability (to generate large relatively sustained downward force under the bow) the following characteristics are favorable: large displacement; high impact velocity; small spread angle complement; low kinetic friction; high waterplace coefficient; high beam to draft ratio. To improve capability of continuous operation the following characteristics are favorable (and not counter to those which favor ramming capability); small bow,angle at design waterline; small spread angle complement; low kinetic friction; high bollard thrust. To reduce extraction difficulty the following characteristics are favorable (and not counter to other goals); small angle complement; low static friction; high backing thrust; large bow angle at waterlines well below the design waterline. A mathematical model is presented which gives the prediction of icebreaking capability (ramming and continuous) in terms of standard ice thickness broken. Additionally, the model predicts extraction difficulty.

Acknowledgement: Engineering Index
Available from: See Introduction "Availability of documents" Item (b)

12 0609

World's present ocean-going icebreaker fleet. *(1976). Shipping World and Shipbuilder 169(april): 336-337.*

Available from: See Introduction "Availability of documents" Item (b)

12 0610

Zefirov, A.S. (1974). **River ice-breaker with wedge-shaped keel**. *Soviet Inventions Illustrated Section 3 Mechanical and General 1974-V(24): p. T4. Patent. (English abstract.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0611

Zefirov, A.S. and M.S. IAkovlev. (1974). **Ice-breaker ship bow end**. *Soviet Inventions Illustrated Section 3 Mechanical and General 1974-V(18): p. T2. Patent. (English abstract.)*

Available from: See Introduction "Availability of documents" Item (b)

12 0612

*Zlobin, G.P. and IU.A. Simonov. (1971). Suda na vozdushnoi podushke. [***Air cushion ships***.] Leningrad: Sudostroenie. 212 pp. Pertinent pages 187-189. (In Russian.)*

Available from: See Introduction "Availability of documents" Item (a)

12 0692

Livingstone, F.R., Dr. M.F. George and T.C. Currie. (1980). **Protection of propellers in ice. Vol. 1: Assessment of protection schemes**. *Ottawa: Davis Engineering Ltd.*

The objective of this project is to develop a method of protecting the propellers of large icebreakers and icebreaking cargo vessels from damage caused by contact with heavy ice.

The risks of damage, loss and pollution with propulsion system failure during northern operations increase dramatically as ships become larger and traffic in northern waters expands. A propeller protection system eliminating ice/propeller contact would not only minimize the risk of damage by ice but would also permit the use of substantially lighter and more efficient propellers and other propulsion system components.

Screening systems for use with propellers are prone to rapid clogging with broken ice and excessive losses in propulsion efficiency. In this project, researchers are developing inflow velocities, ice shedding characteristics, as well as propeller designs that would function efficiently in the flow conditions induced by the screening system.

The project consists of two phases. In the first phase, researchers are to conceptualize the design of propeller and shafting arrangements incorporating protection. The study includes single, twin and triple screw applications. The second phase will consist of model testing to evaluate the protection effectiveness of the proposed arrangement and the propulsion efficiency.

Available from: See Introduction "Availability of documents" item (a)

12 0693

Nawwar, A. and P. Noble. (1980). **Polar Class ice: Load and acceleration forecasts**. *Kanata, Ont.: Arctec Canada Ltd. Final report. (TP 2595).*

The overall purpose of this research is to provide a scientific basis to requisite refinement of those parts of the Arctic Shipping Pollution Prevention Regulations pertaining to Arctic class ships.

The project will provide data on the nature of shock loads and accelerations imposed by icebreaking operations, as compared with open water service, on equipment, mountings and associated structures in vessels. The data are intended to be used for the design of supports and components of nuclear propulsion systems for projected polar class Canadian Coast Guard icebreakers. The data will also be used to obtain a clear indication of the effects of local hull shell plate orientation and of large ship size and mass on ice-hull contact forces.

A mathematical model was formulated to enable simulation of encounters by icebreakers more powerful than any now afloat with ice thicker than any yet faced. The model was calibrated with the results of model tests using both artificial saline ice and synthetic ice. When possible, these results were compared with data from full scale icebreaking operations. The model is now being used to investigate a series of impact situations using a varied set of parameters.

Four ship variations are being investigated, a cargo vessel approximately the size and shape of the M.V. Arctic, a polar icebreaker form of current design, a 100,000 ton Arctic ship and a 100,000 ton polar icebreaker. The ice encounter simulations will offer scenarios representative of various ship speeds, impact locations, growlers and floe sizes and strengths.

Acknowledgement:
Available from: See Introduction "Availability of documents" item (a)

12 0694

Rosandhaug, K. and I. Ernstsen. (1975). **A new generation of supply vessels for use in arctic waters**. *The Copenhagen Offshore Craft Conference, Proceedings of a Conference (Ship and Boat international), Copenhagen, Denmark, 1975. pp. 85-94.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00027-00-AA

12 0695

Voelker, R.P. and J.K. Kim. (1975). **Oceanographic research ship capabilities in ice**. *Ocean '75: 663-667.*

Acknowledgement: OEIC
Available from: OEIC: cite no. C00006-06-38

12 0700

Dome Petroleum Ltd. (1978). **The AML (Arctic Marine Locomotive). The world's most powerful icebreaker**. *Northern Transitions, vol. 2: 368-374. National Workshop on People Resources of the Environment North of 60°. Edmonton, 1978. Ottawa: Canadian Arctic Resources Committee.*

Acknowledgement: OEIC

Available from: OEIC: cite no. C00164-02-AB See also Introduction "Availability of documents" item (a)

12 0734

Arctec Canada Ltd. (1978). **Preliminary guidance specifications for the ice loads on propellers of Arctic Class 7 LNG Ships**. *Volume 1.*

Available from: Petro-Canada: cite no. 115

12 0735

German and Milne. (1978). **Arctic LNG hull form optimization program for Melville Shipping Limited**.

Available from: Petro-Canada: cite no. 194 This is an unpublished report.

12 0736

Melville Shipping Ltd. (1978). **Level ice resistance tests of an Arctic LNG carrier**. *Test Report No. A49.*

Available from: Petro-Canada: cite no. 309

12 0737

Melville Shipping Ltd. (1978). **Model tests of candidate LNG ship hulls (level ice, ridged ice & turning rests)**.

Available from: Petro-Canada: cite no. 319

13 Related Bibliographies

13 0613

*Borisenkov, E.P. et al. (1975). O sredstvakh zashchity sudov ot obledeneniia. [***Means of protecting ships from icing.***] Leningrad. Arkticheskii i antarkticheskii nauchno-issledovatel'skii institut. Trudy, 1975-Vol. 317: p. 4-12. (In Russian.)*

Available from: See Introduction "Availability of documents" Item (b)

13 0614

Bradford, J.D. and M. Moline, compilers. (1980). **Bibliography of northern sea ice and related subjects**. *Canadian Special Publication of Fisheries and Aquatic Sciences 45. Ottawa: Supply and Services Canada.*

The intention in compiling this second edition has been to confine the material to subjects which have a bearing either directly or indirectly on the problem that sea ice presents to vessels. While geographically the emphasis is Canadian, works which describe the experience of other countries in northern sea ice operations, science, and technology have been included. In compiling the second edition over 700 new entries have been added and a sincere effort has been made to correct the inaccuracies, inconsistencies, and errors which were reported in the first edition. The bibliography now contains references to materials published up to 1974. A new feature of this edition is the inclusion of a geographical index. ...(Author).

Acknowledgement: ASTIS

Available from: Department of Fisheries and Oceans Canadian Coast Guard

13 0615

Dunbar, M.J. (1980). **Marine transportation and high Arctic development: a bibliography of scientific and technical research relevant to the development of marine transportation in the Canadian Arctic**. *Ottawa: Canadian Arctic Resources Commitee.*

Available from: Canadian Arctic Resources Committee
Price: $7.50

13 0616

Dvorak, George J. (1972). **Design of river icebreakers: library search of Russian and European literature**. *Durham, N.C.: Duke University, Dept. of Civil Engineering. 133 pp.*

Library search for literature in the field of design of river icebreakers was made. The purpose of this search was to collect, review and make documentation of Russian and German literature, published between 1967 and 1972, which was pertinent to the main subject. Special reference was given to structural design, propulsion, and to materials and processes used in construction as well as to physical properties of ice, to icebreaking theory and methods, and to problems related to the interaction between the icebreaker and ice. This report describes the main features of the work, its scope, sources, and results. It contains technical information on the documentation and on copyright clearance. Bibliographical data, abstracts, and key words of all references included in this research are listed in numerical order within seven subject categories. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-A024 897/IST

13 0617

Dvorak, George J. (1972). **Design of river icebreakers: library search of Russian and European literature: supplement** *volumes 1-13. Durham, N.C.: Duke University, Dept. of Civil Engineering.*

Available from: NTIS cite nos. AD-A020 605-AD-A020 617.

13 0618

Dvorak, G.J. (1974). **Development of icebreakers and icebreaking methods: library search of Russian and European literature**. *Durham, D.C.: Duke University, Dept. of Civil Engineering. 166 pp.*

A library search was made for literature in the field of icebreakers and icebreaking. The purpose of this search was to collect, review, and report on the Russian and German literature published within the last five years pertinent to the main subject. Special attention was given to ice resistance to ship passage, new icebreaking methods, design of propulsion systems for icecutters, determination of optimum operation periods for icebreaker escorts, and research and development reviews and surveys. This report describes the main features of the work, its scope, sources, and results. References are listed in numerical order within five subject categories. See also report dated April 68, AD-670 631.

Acknowledgement: NTIS
Available from: NTIS: cite AD-A018 631/2GA

13 0619

Dvorak, G.J. (1974). **Development of icebreakers and icebreaking methods: library search of Russian and European literature: supplement**. *Durham, N.C.: Duke University, Dept. of Civil Engineering. 3 vols.*

Library search was made for literature in the field of Development of Icebreakers and Icebreaking Methods. The purpose of this search was to collect, review, and make documentation of Russian and German literature published within the last five years which was pertinent to the main subject. Special attention was given to the following subjects: (a) Ice resistance to ship passage: (b) New icebreaking methods: (c) Design of propulsion systems for icecutters; (d) Determination of optimum operation periods for icebreaker escorts; (e) Research and development reviews and surveys. This report contains copies of the Russian and German references identified in the subject literature search. Bibliographical information, an abstract, and key words are included with each reference. The references are listed in numerical order within five subject categories.

Acknowledgement: NTIS

Available from: NTIS: Vol.1. cite AD-A018 631 Vol.2. cite AD-A020 603/7ST Vol.3. cite AD-A020 604/5ST

13 0620

Itagaki, K. (1977). **Icing on ships and stationary structures under maritime conditions: a preliminary literature survey**

of Japanese sources. *Hanover, N.H.: Cold Regions Research and Engineering Lab. 26 pp.*

This report reviews Japanese literature on ship icing, including direct measurements of ice accumulated on ship, ice accretion rate and sea spray flux as well as statistical analyses of icing conditions. The report also describes some possibilities of forecasting icing conditions. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite PC A03/MF A01

13 0621

Jones, Norman. (1979). **Literature survey on the collision and grounding protection of ships**. *Cambridge, Mass.: Massachusetts Institute of Technology. Ship Struct. Committee Report SSC US no. 283. 60 pp.*

This article focuses on the structural response of ships during collisions and groundings, and does not discuss other important topics such as traffic and pollution control and collision and stranding probabilities. The field of collision protection is not only relevant to the design of nuclear-powered submarines and aircraft carriers and a few other vessels examined in the earlier work, but now includes within its province, oil tankers, LNG carriers, and chemical carriers with hazardous cargoes. Moreover, existing studies must be continued, or even initiated in some cases, to investigate the collision protection of large nuclear-powered tankers (60,000 dwt), the effects of collisions between supply ships and various offshore structures, collision protection of offshore oil storage tanks, protection of ships transporting spent nuclear fuels to nuclear reprocessing plants, the protection of bridge piers against ship impact, ice collision damage of ships navigation in Arctic waters. 77 refs.

Acknowledgement: Engineering index
Available from: See Introduction "Availability of documents" Item (a)

13 0622

Minsk, L. David. (1977). **Ice accumulation on ocean structures**. *Hanover, N.H.: Cold Regions Research and Engineering Lab. Report no. CRREL-77-17. 47 pp.*

A literature search was made for information on the accretion of ice on ocean structures and on the methods for control. The bulk of the reports were in Russian, with some additional Japanese, British, American, Canadian, and Icelandic sources. Analysis of icing reports indicated that sea spray is the most important cause of ship icing, with lesser amounts due to freezing rain, snow, and fog. Icing is a potential danger whenever air temperatures are below the freezing point of water and the sea temperature is 6 C or lower. Theoretical work on the ice accretion process is discussed, and a method is suggested, based on Russian experiments, for calculating the sea spray accumulation rate for cylindrical and flat surfaces as a function of water source temperature, air temperature, and wind speed. Other factors that influence icing severity are ship size and configuration, angle between ship course and water heading, and ship speed. Icing in the northern temperature latitudes generally occurs in the rear of barometic depressions. Maps showing limits of various degrees of icing severity are included. Atmospheric icing measurements on tall land-based structures are presented, and potential maximum accumulations estimated. Control measures are discussed, though no completely effective method is available. Mechanical (impaction) methods are the most common, but experiments have been concluded on heated, icephobic, and deformable surfaces, and with freezing point depressants. No device for the unequivocal measurement of ice accumulation is available, though some experimental methods are suitable for controlled testing; it is recommended that a device be developed. (Author)

Acknowledgement: NTIS
Available from: NTIS: cite AD-A044 258/2ST

13 0623

National Research Council. Transportation Research Board. (1978). **Marine systems in frigid environments: special bibliography**. *Washington, D.C.: National Academy of Sciences. 35 pp.*

Increasing activity in the development of natural resources in the cold regions of the world has led to a growing interest in commercial marine transportation systems and related facilities. Recognizing the need for dissemination of pertinent data and information critical to the design of vehicles, system components, and support facilities, the MS-9 Panel (Ocean Engineering in Frigid Environments) of the Society of Naval Architects and Marine Engineers identified the need for a selected bibliography for use by designers and planners. This special bibliography is intended to fill that need. This special bibliography contains 175 abstracts of selected reports and journal articles that cover the range of problems associated with marine systems that operate in ice-covered waters. The major emphasis of this material is on marine transportation rather than marine structures. The abstracts were selected from those that are contained in the computer tape records of the Maritime Research Information Service under subject area 01. Arctic and Cold Weather Operations, 1 of 24 subject areas used to classify material in MRIS. Price is $7.00

Acknowledgement: MRIS
Available from: Transportation Research Board Publications Office Maritime Research Information Service 2101 Constitution Avenue, N.W. Washington, D.C. 20418
Price: $7.00 U.S.

13 0624

Nawwar, A.M. et al. (1979). **Development of a research programme for improving Arctic marine transportation technology: volume III: bibliography**. *Kanata, Ont.:Arctec Canada Ltd. Final report 188C-6. 41 pp. (Canada Ministry of Transport, Report no. TP 2005)*

Available from: Transportation Development Centre, Montreal (limited number) Tel: (514) 283-4088

13 0625

Swan, K.T. (1977). **A survey of icing conditions for marine gas turbines**. *Trenton, N.J.: Naval Air Propulsion Test Center, Propulsion Technology and Project Engineering Dept. Final report. 70 pp.*

A literature survey was conducted to define the possible hydrometeorological conditions during which icing of the gas turbine inlets of a ship could occur. Also included is a list of all sources of information used during the survey. A frequency-of-occurence study of the icing conditions found during the literature survey was also done and the results included as maps of the North Atlantic. The North Atlantic was chosen as it gave the most complete data base available at the time.

Acknowledgement: NTIS
Available from: NTIS: cite AD-A045558/4ST

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08 0298

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08 0302

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08 0317

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11 0397

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11 0398

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11 0424

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11 0432

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11 0435

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11 0448

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